SIXTY-EIGHTH YEAR

SCIENTIFIC AMERICAN

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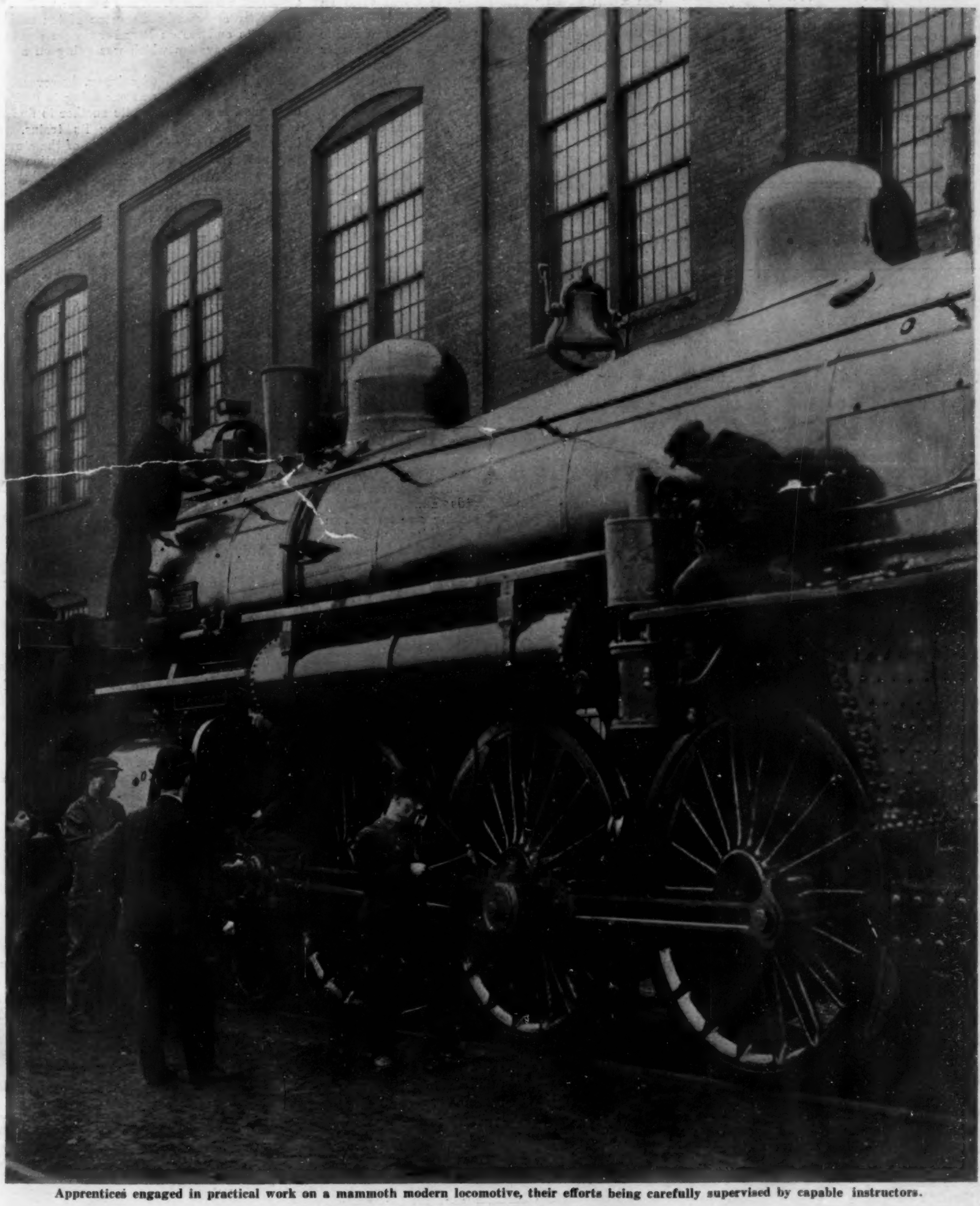

Apprentices engaged in practical work on a mammoth modern locomotive, their efforts being carefully supervised by capable instructors.

HOW RAILROAD MEN ARE MADE. [See page 158.]

SCIENTIFIC AMERICAN

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

Fire Towers as Life-savers

THERE are some means for life-saving in the event of an outbreak of fire, which are so obviously efficient that their immediate adoption would seem assured. We do not hesitate to name the fire-tower as by far the most important and effective of such devices.

A fire-tower to be worthy of the name must be a substantial structure, erected preferably on the outside of the factory or office building, built of thoroughly fireproof materials, and provided with generous means of access from every floor of the building. Within the tower should be broad steel stairways, of sufficient capacity to accommodate, without undue crowding, a sudden rush of the more-or-less panic-stricken occupants of the building.

In the ideal fire-tower there should be no openings leading directly from the building to the tower. If the site will permit, it should stand a few feet from the building, with access from each floor by means of a steel bridge. If the tower must be built adjoining the building, a steel gallery should lead, at each floor, from the factory, around the tower, to an entrance on its outer wall. If no court is available for the tower, and it must be built within the factory or office building, entrance should be had by a steel gallery, at each floor, exterior to the building. In no case should there be openings directly from the building to the tower. Furthermore, to protect the escaping occupants from ascending smoke and flame, all galleries should be inclosed—preferably with a steel-and-tile or steel-and-asbestos covering.

Now here is a method of protection which would absolutely prevent the occurrence of such a disaster as the Asch fire in this city. True, it would add to the cost of construction; but in proportion to the security afforded, it would represent a moderate outlay. An ancient writer once asked the question, "How much, then, is the life of a man worth more than that of a sheep?" It is a question that is pertinent—alas, only too pertinent—to-day. We believe that proper agitation of this question would lead to legislation calling for properly built fire-towers as an indispensable part, at least of every factory of the type of the notorious Asch building.

The Question of Canal Tolls

THERE are many reasons why the subject of the management of the Panama Canal should receive the most thoughtful attention of Congress. Particularly is this true of the all-important question of tolls, and we are glad to note that there is promise of its settlement upon a basis at once statesmanlike and commercially prudent, in the fact that there is a growing conviction that the success of the Canal will depend first and last upon the wisdom of such toll legislation as may be enacted.

A careful study of prevailing sentiment in Congress, in the press, and as expressed by the average citizen, reveals a growing conviction that the Panama Canal, because of its magnitude and cost, must be considered by itself, and that it is unwise to apply too closely the arguments which have determined the policy adopted for other canals of less importance.

As between the extremes of a canal absolutely free to the world, and a canal burdened with a rate of toll that would cover the fixed charges, and even yield a clear revenue, we believe the wiser course will be found in a compromise—the imposition of a system of tolls, for instance, which, while paying for the cost of maintenance and operation, would not be so onerous as to discourage such trade as would be drawn to the Canal by the advantages of shorter sailing routes which it offers.

We believe that any attempt to levy and maintain a toll which would make the Canal yield an actual profit on the investment, would be doomed to certain failure. Those people who are unable to regard this great enterprise from a broader standpoint than that of an investment made for what it will return in cash, should remember that by making our fleet quickly available in two oceans the Canal will practically place at the disposal of the United States a new fleet, of a value of two or three hundred million dollars—a return on the outlay which should surely satisfy the most exacting.

Granting that the imposition of a moderate toll will be consistent with the best interests of both of the Canal and the general ocean-borne trade of the world, we believe that the United States would be justified in doing everything possible, consistent with treaty and other obligations, to make the Canal a powerful factor in stimulating our own moribund merchant marine. Hence, we are inclined to look favorably, at least upon the spirit of the bill, recently introduced by Senator Bristow, for fixing the rate of tolls for the Canal.

According to this bill a general rate is fixed for all shipping of one dollar per ton. But all American ships, whose owners agree that such vessels shall be at the service of the United States in time of war as auxiliary cruisers will pay only fifty cents per ton, while all ships engaged in the coast-wise trade, under the same stipulations as to their use as auxiliaries, shall have the benefit of a rate of twenty-five cents a ton.

The canal is to be safeguarded against hostile combinations between railroads and steamships, made for the purpose of diverting commerce from the Canal, by levying upon the shipping of such interests a toll of two dollars. And, furthermore, the bill makes it unlawful for any railroad to own or control ships that will regularly make use of the Canal.

Now, although there may be some difference of opinion upon the last-named provision, there can be none as to the wisdom of the section which declares that all routes from the interior points of the United States to ports of the United States which are made through the Canal are to be regarded as through routes, and the Interstate Commerce Commission is to control the rates and to prescribe the proper division of these rates between the water line and the railroad.

Senator Bristow it should be mentioned, holds that our treaty with Great Britain does not forbid such reductions for American vessels as are suggested above, and if this be true, we consider that the bill, if enacted into law, whether as it stands or in some modified form, would prove to be a powerful factor in the double work of upbuilding our merchant marine and providing the United States Navy with the various auxiliaries of which it stands so greatly in need.

Subways Old and New

THE announcement that the contract has been let for building the section of the New York Subway beneath Broadway from Park Place to Walker Street, brings to mind the fact that the contractors will find that a certain amount of the work of excavation along this section has already been completed; for in the course of their work they will come upon an old construction in the shape of a brick-lined subway, which has been in existence between Warren and Murray streets for over forty years. What is more, they will find within this subway a complete car, which after carrying passengers on experimental trips, has remained sealed up in its brick-lined vault beneath the streets of a busy city.

The SCIENTIFIC AMERICAN feels a particular interest in this early attempt to provide New York with rapid transit; for the pioneer line built in the sixties was planned and constructed by the late Mr. Alfred Ely Beach, who in partnership with the late Mr. Orson D. Munn founded the SCIENTIFIC AMERICAN. The tunnel was built in 1869 under a franchise granted in 1868 "for the transmission of letters, packages, and merchandise by means of pneumatic tubes to be constructed beneath the surface of the streets and public places." In 1873 the charter was amended so as to permit the company to "construct, maintain and operate an underground railway for the transportation of passengers and property." The proposed route was from the Battery under Broadway to Central Park, with a branch under Madison Avenue to and under the Harlem River.

In view of the popular impression that the method of excavation by the hydraulic shield, as used under the Hudson and East rivers, is a feat of modern engineering there is food for thought in the fact that not only was this tunnel of 1869 driven by means of a hydraulic shield, but the work was done so quietly and neatly that none of the crowds that passed to and fro on Broadway were aware of the work of excavation which was going on a few feet below street level.

This little stretch of subway, however, was far ahead of its day. It was one thing to build an underground railway and quite another to find a satisfactory method of operating its trains. Steam, because of the attendant vitiation of the atmosphere, was not available, and electric operation of trains was as yet a dream of the future. Therefore, in view of the fact that the company had been formed originally for the dispatch of mail and packages by the pneumatic or vacuum system, it was but natural that the same method should be applied on a larger scale to the operation of trains. Hence, the experimental car was built to conform closely to the cross section of the tunnel; a plant for exhausting air from the tunnel in front of the car was installed, and in due course of time the era of subway travel in New York was inaugurated. For passengers were actually carried (experimentally it is true) from Warren to Murray streets in this curiously-shaped, but not uncomfortable pioneer subway passenger car.

Not alone in the matter of transportation did this venture have to struggle against the limitations imposed by the yet undeveloped state of engineering; for a report of the Chamber of Commerce tells us that the civil engineers of that day doubted if it were feasible to drive a tunnel adjacent to the so-called "massive" buildings, prominent among which was the old Astor House. Skeleton-steel buildings and reinforced concrete had not yet been developed, and contemporary engineers were perhaps justified in their reluctance to disturb the ground adjacent to the foundations of the buildings which lined the proposed route.

Scientific Terms

WE recently took occasion to comment on the fact that most educated people, scientific men included, are surprisingly unfamiliar with the terminology of atmospheric optics. Within a few days of the publication of our note on this subject, there appeared in the *Bulletin of the American Geographical Society*, from the pen of Prof. W. M. Davis, an article complaining of the neglect of scientific terminology in quite a different branch of knowledge, viz., physical geography. Prof. Davis' remarks, like our own, were prompted by an article in *Nature*, taking him to task for recommending the more general use of technical terms in geographical descriptions, the basis of the objection being that such terms "might be more misleading than any empirical description if employed wrongly or applied without sufficient warrant." Replying to these objections, Prof. Davis points out the extent to which botanical terminology is tolerated in comparison with geographic terminology. Thus, supposing a traveler should induce the Linnæan Society to publish in its journal an untechnical account of his observations on certain plants, and should state therein, in regard to these plants, that the flower stems spread out from a common center, so that the blossoms meet above in a gently convex surface of approximately circular border, a botanist, reading this description, would doubtless suggest that "such flowers might be more briefly described as umbellifers." Would *Nature*, asks Prof. Davis, then comment on such a suggestion by saying that "a term like *umbellifer* might be more misleading than any paraphrase if wrongly employed"? While specific scientific terminology, like all other good things, may occasionally be overdone, it remains a fact that no precise scientific writing is possible without it. It is inevitable that there will often be differences of opinion as to the fitness of a particular term to survive. The difficulty can only be met by conferences among the persons most interested.

Engineering

The "Maine" Once More Afloat.—Last week the wooden bulkhead which has been built across the forward end of the unwrecked portion of the "Maine" being completed, sufficient water was admitted within the cofferdam to free the hull from the mud into which it had deeply settled. The "Maine" rode on a fairly even keel, but on account of the removal of heavy weights and particularly of the after-turret with its two ten-inch guns, the hull floated considerably above its normal water line.

Saving of Distance by the Canal.—The opening of the Panama Canal will effect the following saving of distances for such ships as may choose the new and shorter route: Europe to San Francisco, 6,200 miles, and to Valparaiso, 2,100 miles; England to New Zealand, 1,600, and to Australia, 800 miles. Between American and Oriental ports the saving will be as follows: New York to Shanghai, 1,400 miles; Montreal to Sydney, Australia, 2,740 miles; and between New York and Australasian ports the saving of distance will average about 2,400 miles.

Train-lighting Instruction Car.—A train lighting instruction car has been placed in service by the Pennsylvania Railway for the instruction of workmen. This company has at present eight distinct axle lighting systems, in addition to several arrangements of storage battery equipment. It is intended to send this car to different points where yard electricians are stationed. The equipment of the car consists of a 32-cell storage battery, a 15-kilowatt Curtis turbo-generator, a variable speed motor with control apparatus for driving the several axle generators, and six makes of the last with regulating equipment.

Field for American Agricultural Machinery.—The enormous wheat fields of the Punjab, states the *Contract Journal*, afford another instance where, if proper arrangements were made, the demand for agricultural machinery would soon equal that of the western prairies in America. The fields are, in a great measure, in the hands of small proprietors, who could not afford to buy any machine outright, but if they could hire them at a reasonable rental they would jump at the opportunity. It is reported that one firm of agricultural machine makers has already got an agent on the spot with that end in view; there is room for any number of agents.

The Largest Atlantic Coast Drydock.—The completion of drydock No. 4 at the Brooklyn Navy Yard marks the conclusion of an engineering work of unusual perplexity and difficulty. More than one contractor abandoned the work in utter discouragement or through financial inability. Failure was due mainly to the fact that the site of the dock included a large bed of quicksand, which moved in upon the excavation and rendered it necessary to devise an altogether novel method of construction. Accordingly a continuous retaining wall of concrete was sunk entirely around the site, massive piers of concrete were put through to the solid bottom, and the dock was built within and upon these structures as thus prepared.

The Increase of Turbine Efficiency.—The increase in turbine efficiency has been rapid and striking. A Parsons turbine of four-kilowatt power, built in 1885, using saturated steam and working non-condensing, used 200 pounds of steam per kilowatt per hour. Another unit of 75 kilowatts power, built in 1888, using saturated steam of 100 pounds pressure and working non-condensing, required 55 pounds of steam per kilowatt per hour. Another turbo-generator of 100 kilowatts capacity, built in 1892 and using a condenser, brought the steam consumption down to 27 pounds per kilowatt hour. A 1,250-kilowatt turbo-generator, built in 1900, working with a condenser, lowered the consumption to 18.22 pounds per kilowatt hour, and a 5,000-horse-power unit, in 1910, using 200 pounds of steam and 120 degrees of superheat, with a vacuum of 28.8, has reduced the consumption to the low figure of 13.2 pounds per kilowatt hour.

Revenue in Public Water Power.—A recent report of the new Conservation Commission, which has just been submitted to the New York State Legislature, finds that the waters of the State which are under public ownership and control, with the undeveloped water rights in the development of which private interests will have to be taken into consideration, furnish a total flow representing a capacity of 1,271,000 horse-power. Ordinarily, development for manufacturing purposes is based upon an estimate of only 60 per cent of the time of continuous flow. A well-considered plan of conservation would yield an available horse-power of about 1,780,000. In an investigation before the Foreign Affairs Committee of the House of Representatives it was shown that the Ontario Power Company of Niagara sells electric power for $9.40 per horse-power; from which figures it will be at once evident how large a source of income will be available to the State, whenever it takes in hand the economical administration of its water powers.

Science

Asbestos in Sardinia.—Asbestos has been lately found in some quantities in Sardinia as a result of a geological examination, so that a good supply could be obtained there. The region containing the mineral lies around Mt. Aspro.

Meat Powder.—Only the best beef obtainable should be used. This is cut into small pieces and fat removed as much as possible. It is then finely chopped and spread on glass plates and left to dry near a stove or furnace. When perfectly dry, it is removed and ground to a fine powder. The latter is packed into a percolator and treated first with ether and later with ethyl alcohol. It is then allowed to dry and is finally passed through a fine sieve or through gauze. A preparation of this kind has been on the market under the name of "poudre de viande."

Exploration of Lower California.—The interior of Lower California is to-day nearly blank on our maps, and is possibly less well known from a geographical and a geological standpoint than any other region of equal area in North America. The Mexican government has at last begun a thorough exploration of this terra incognita. During the past autumn the Instituto Geológico equipped four parties, each comprising two geologists, to explore the northern part of the peninsula. The work will be extended to the southern part this year.

Alcohol from Chicory.—In Germany, alcohol is now prepared from chicory root which grows in various parts of that country, especially near Magdeburg and Brunswick. Chicory root has been found to contain nitrogenous matter 4.86 per cent, fats 1.61 per cent, sugar 12.45 per cent, inulin 72.72 per cent, cellulose 5 per cent and ash 3.1 per cent. From 100 kilogrammes of the root, 52 liters of juice are obtained; by a process of freezing the inulin is isolated; 100 pounds of the juice will yield about 8.4 liters of alcohol when subjected to a special process of fermentation.

Artificial Sponge.—The manufacture of artificial sponge is based on the action of zinc chloride on pure cellulose, which has been mixed with coarse rock salt. This mass is subjected to pressure by a press, provided with pins which serve to pierce through the mass, thus making tiny canals, looking very much like the pores of the natural sponge. It is mashed very thoroughly in a weak solution of alcohol to remove the excess of salts. This sponge swells up with water and hardens on drying, just like the genuine article. It is especially adapted for filtering drinking water, but can be used for all purposes to which the natural product is applied.

Removing Old Lacquers and Varnishes from Oil-Paintings.—The following liquid is recommended by M. Rubini, according to a German patent: 1,000 grammes of weak alcohol (rum) are mixed with 90-120 grammes of oil of cloves and 90-120 grammes of ether; in a separate vessel equal parts (by weight) of paraffin oil and oil of turpentine are mixed; 500 grammes of each of the two solutions are brought together, whereupon a solution of 25-50 grammes table salt in 400-600 grammes of distilled water is added. This liquid must be well shaken until it forms a milky emulsion. It is then ready for use. A piece of cotton wool is wetted with this solution and rubbed over the painting. Fresh pieces of cotton must be used until the tuft remains perfectly clean on going over the painting. If the lacquer should be very old and dark, the surface of the painting may be covered with the liquid and then rubbed off with cotton wool. It will be found that the painting will regain its original fresh and deep colors, the liquid causing no injury whatever.

Banana Cloth.—There is not a village in India that has not its clump of banana trees and not a village in which the fruit is not gathered and the fiber in the stalk wasted. It has been left to the Chinese to teach us how the tons of banana fiber thrown on the rubbish heap every year can be converted into banana cloth and sold at a most remunerative price. The process of manufacture is very simple and quite within the reach of the natives of India, particularly those—and there are thousands of them—who have had some little textile training in cotton or jute mills. One year old plants are selected and the stalk is unrolled and steamed over cauldrons of boiling water till soft. It is a simple matter then to remove the green outer skin, by passing strips of the stalk through an instrument provided with a couple of blunt blades, which act as scrapers. The fiber thus obtained is placed in cloth, and pounded, in order to drive out excess moisture, and is next cleaned and twisted into yarn for weaving. Banana cloth is said to be eminently suitable for tropical wear and is very durable. At present the price would seem to be almost prohibitive, as a roll of banana cloth, five yards long and one yard wide sells for about $5.70. As this enterprise is a brand new one, high prices are to be expected; but they are sure to right themselves as the demand for this kind of cloth grows, and the supply endeavors to keep pace with it.

Aeronautics

Italian Aviator Shot in War.—Capt. Monte, of the Italian military aviation corps, is the first aviator to be wounded while dropping bombs in actual warfare. On February 1st, while flying with an observer above an Arab encampment in the desert, near Tobruck, in Cyrenaica, and dropping bombs upon it, Capt. Monte was hit by a rifle ball and severely injured. Despite his injuries he managed to fly back to the camp and alight safely, bringing valuable information. The aeroplane was hit no less than four times by bullets. Charles A. Willard, while flying in the Middle West, once had a propeller splintered by a bullet from a farmer's rifle, but the case above cited is the first on record where an aviator has himself been hit. Capt. Monte's experience demonstrates that war aeroplanes should have the seat for the pilot and observer protected by light armor and the men themselves should wear bullet-proof clothing such as has recently been brought out in Japan.

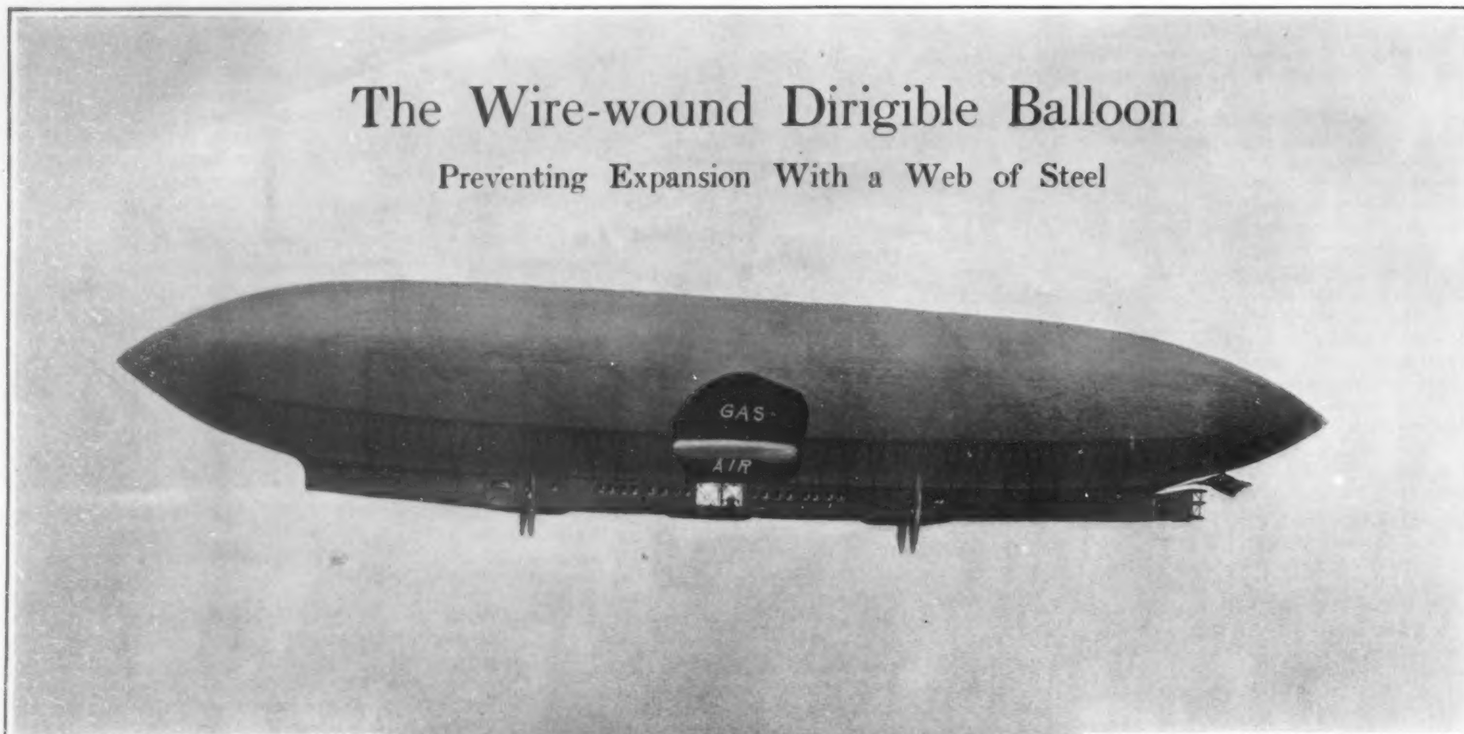
Contest of Hydro-aeroplanes at Monaco.—Almost exactly two years after the first flight starting from the surface of the water was accomplished, there will be held at Monaco an international hydro-aeroplane contest. This competition, under the auspices of the International Sporting Club of Monaco, will be held during the motor boat races, from the 24th to the 31st of March. Doubtless a Curtiss hydro-aeroplane will participate, as several of these biplanes have been shipped abroad of late. The new model, described in our last issue, is particularly adapted to a heavy sea such as is likely to be experienced at Monaco. Last week Frank Coffyn gave a remarkable demonstration of the Wright hydro-aeroplane in and over the Hudson River. In starting and alighting the aluminium floats hit floating cakes of ice, but without injury. On the 7th inst. Coffyn took up a newspaper photographer, who secured excellent photographs of New York harbor and its fortifications. Possibly one of the Wright machines will participate in the Monaco contest. Prizes totaling $3,000 are offered.

Recent Fatal Accidents.—On January 22nd at the Los Angeles aviation meet, Rutherford Page, a daring young amateur pilot of a Curtiss biplane, who had obtained his license only a few days before, fell to his death when racing Lincoln Beachy in a strong wind. He beat Beachy in a 5-mile race, as he had said he would do, but immediately after he fell headlong to the ground and was instantly killed. Two other fatal accidents occurred in France on the same day. Both were to beginners. Lieut. Boerner, who had flown for several weeks only, descended sharply from 1,000 feet with motor running, and in checking his descent pulled back too far on his control lever. The machine lost headway and "pancaked," i. e., landed flat on the ground with motor running. It caught fire and Lieut. Boerner was badly burned, though not injured otherwise. Alfred Wagner, a youth 21 years old, slid sideways to the ground in making a right turn while practising the figure eight. The machine was smashed and Wagner was instantly killed. Franz Reichalt, an Austrian tailor, jumped on February 4th, from the first platform of the Eiffel tower to test a safety parachute of his own invention. He made the leap against the advice of M. Hervieu, an expert and the inventor of a similar device. The parachute did not open, and the foolhardy tailor was instantly killed by the fall of 180 feet. His death rather dampened the ardor of Aviator Guillaume, who was planning to leap from a monoplane with a parachute when at a height of 1,000 feet or more.

Wonderful Speed Records in France.—The Pau aerodrome has recently been the scene of some record-breaking speed flights in which the records of the late Edouard Nieuport, made a year ago, were shattered. On January 19th Vedrines, on a 100-horse-power Gnome-engined Deperdussin monoplane broke Nieuport's records for all distances from 5 to 40 kilometers, his 100-kilometer (62.1-mile) record, and C. T. Weymann's 150-kilometer (93-mile) record made in a 100-horse-power Nieuport monoplane when he won the Bennett Cup race on July 1st, 1911, in England. Vedrine's records for 5, 10, 20, 30, and 40 kilometers in minutes and seconds, are, respectively, 2:06 2/5; 4:13 2/5; 8:26 3/5; 12:40 4/5; 16:53. One hundred kilometers were covered in 41:56 4/5 as against 46:27 2/5 by Nieuport; and 150 in 62:43 4/5 as against 71:36 1/5 by Weymann. In one hour Vedrines flew 142.43 kilometers (88.50 miles), showing that his speed was 8 1/3 miles per hour faster than that attained by Nieuport. The fastest speed made in any 5-kilometer circuit was 145.177 kilometers, or 90.2 miles an hour. This was 7½ miles per hour faster than Nieuport's fastest lap. On January 24th Maurice Tabuteau, with a Borel monoplane, made new records for 200, 250, and 300 kilometers (124.28, 155.35, and 186.41 miles) of 1:54:21; 2:22:57; and 2:51:00, respectively. His average speed for the first-mentioned distance was 64.87 miles per hour. In 2 hours he covered 205.287 kilometers (127.56 miles) and in 3 hours 316.287 kilometers (196.53 miles).

The Wire-wound Dirigible Balloon

Preventing Expansion With a Web of Steel



DESIGN OF THE NEW WIRED-FABRIC AIRSHIP

IT has not always been clear to the public mind what benefits would accrue from over-sea airship expeditions, and criticisms have not been lacking concerning the Arctic and Atlantic essays which were undertaken without any prolonged, previous trials. But those perilous ventures have resulted in a most promising development, namely, the solution of the vexing problem of equilibrium in sustained flight. The heavy guide rope used by Andree's balloon over the Arctic and on the "America," could not be tried out over land or in civilized countries. It was not any deficiency in construction of the airship, in the "America's" two Arctic voyages, which was the cause of failure to reach the Pole. Those two campaigns resulted in signal improvements in dirigible equipment; for instance, in the matter of the instruments of navigation, it was found that absolutely new forms must be invented since the compass pointed north, but did not tell in which direction the airship traveled. The precedent of the guide rope was followed with entire satisfaction, but as the first campaign had to be terminated because of the improper equipment of instruments, the second attempt was frustrated when the guide rope accidentally broke away from the car. Mr. Melvin Vaniman, the engineer of the expedition, no doubt counts the fourteen hours in the air that followed, as among the most valuable experienced in his aeronautic career. The ship was not designed for and could not have traveled over land, and the defects of the equilibrator were not yet known. In the first venture over the Atlantic, when the question of ballast assumed even greater importance than it had in the comparatively unfluctuating conditions of Arctic temperature, the equilibrator became, in heavy, steady winds, a drag, preventing speed and interrupting steering. The terrific wind gusts showed its fatal defects and decided Mr. Vaniman forever to abandon the guide rope or fixed ballast.

In constructing the "Akron" this was provided against by a device that could be made heavier or lighter at will, using sea water as the changeable ballast. This was later simplified into a device called the "hydro-leveter," by which water could be taken from the sea and stored in the airship where it could be thrown overboard as desired.

One of the means provided for bringing the "Akron" down from a great height was the construction of a balloon fabric, the strongest ever used in a dirigible. By continually pumping air into the ballonets and thus adding air ballast to the balloon, the "Akron" can be brought from any height to the surface of the water. It was in this way that from a height of over 2,000 feet, after an accident to one motor and the breaking of the propeller shaft of the other, he brought the ship to a safe landing and anchorage in the shallow water of the meadows near Atlantic City, and was finally able to get the ship safely back to the shed, practically unharmed. The press and public never guessed the engineering value of that short journey and to what development it would lead.

At once Mr. Vaniman began to study the possibilities of this powerful control over the gas. He calculated the strength of a fabric that would resist the increased pressure in the gas bag due to a rise in temperature of 50 degrees of heat. With only a small coefficient of security for safety, it was found that the tensile strength necessary was 1,000 pounds to the inch, or 18 tons to the yard. The use of the finest piano wire and a special way of building up the fabric of the envelope would make this practical, the piano wires to be so interwoven in the fabric as to run longitudinally and circumferentially without cuts or joints so that their maximum tensile strength may be relied upon, the longitudinal wires being spaced 1/16th of an inch apart and the circumferential wires 1/32nd of an inch. This fine mesh renders the hydrogen containing envelope fireproof and lightning-proof on the principle of Davy's lamp. Undoubtedly interesting results will be obtained by using this mass of wire fabric in connection with wireless telegraph apparatus.

On an airship like the "Akron" the increased weight due to the steel wire would be 2½ tons. Once having the fabric of sufficient strength, no guide rope, equilibrator, hydro-leveter, or any other form of ballast would be needed; the ship could travel safely over land and sea.

The accompanying drawing gives a graphic idea of the form and control of Mr. Vaniman's new airship on which work has commenced. The shading shows how the density of the atmosphere increases as the airship descends toward the earth. Suppose the ship in the drawing is 1,000 feet above the sea and it is desired to bring it down. By continually pumping air into the ballonet the weight of the balloon is increased and the airship will gradually descend as long as the pumping continues, and stop when it is discontinued. The ship will remain at this height even though the sun strikes the envelope and heats both air and gas. The envelope is strong enough to resist the expansion and the ship must continue at this level because the displacement will be constant though the pressure of the gas will continue to rise as the heat increases. If it is desired to go to a higher altitude, the air in the ballonet is allowed gradually to escape, and the airship rises until the valve is closed, when the ship stops and remains at that height, unaffected by atmospheric changes.

Although the "Akron's" envelope is strong enough to resist, with an ample factor of security, 1½ inches water pressure, the same envelope reinforced with 2½ tons of spider-web-like piano wire, would resist 52 inches of water pressure. There is a tendency for hydrogen to pass through the rubber fabric, and the diffusion increases with the pressure. To prevent this a coating is applied to the inside of the now practically rigid envelope. The fabric is treated while stretched to the utmost by the internal pressure. The inventors of this process have employed it in the manufacture of an article where an air pressure of 2,200 pounds was held for four years without showing any apparent leakage through the rubber envelope.

The additional weight of the steel would reduce the net carrying power of this ship from 7½ tons to 5 tons, but the advantages obtained would warrant the sacrifice. In comparison with the weight of the rigid dirigible construction, this net carrying power is quite remarkable. The latest Zeppelin, the "Schwaben," with 680,000 cubic feet of gas, has a net carrying power of about 2½ tons, while the "Akron," with the steel reinforced gas bag holding only 400,000 cubic feet of gas, would have a net carrying power of five tons. This enormous dead weight of the rigid Zeppelins has never definitely solved anything and has in no way influenced the real problem; for which reason engineers of other countries have never followed the rigid system of dirigible construction, and it has not been adopted by any nation as the type for military work. France uses the semi-rigid and non-rigid dirigibles, as do Germany, Russia, England, Italy, Austria, and Spain.

Reinforcing the fabric of the gas bag would go to the very heart of the problem. It would automatically take care of the expansion and contraction of the gas due to heat and cold and make it possible for the dirigible to remain in the air over land or sea for weeks and even months. It would give a powerful control enabling the pilot to change his altitude, to rise or descend at will without loss of gas or ballast, use of planes or motors. It would utilize the air in which it moves as its power of control and would be perfectly at home in its own element. It is not expected that the "wire wound" dirigible will crowd out the aeroplane which supports itself in the air by the power of its propelling engines, but for the economical transportation of passengers, merchandise, troops or explosives, a machine which requires fuel only for onward propulsion, which is in no danger of turning turtle, of dropping into air pockets, or of falling through failure of motors, must unquestionably be the ideal craft.

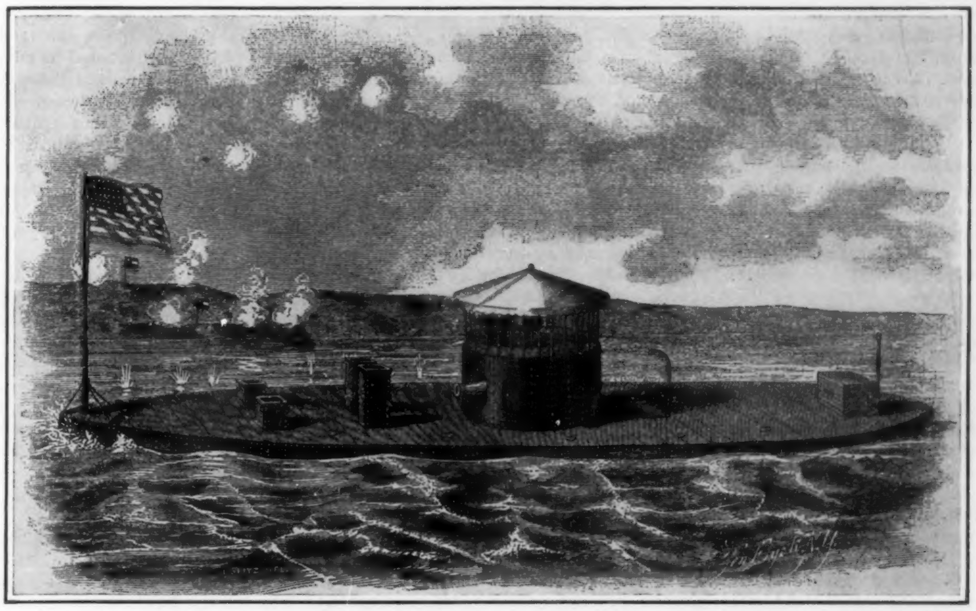
The Jubilee of the Turret-ship

In Its Essentials the Turret Has Changed Very Little in the Fifty Years of Its Life

By Percival A. Hislam

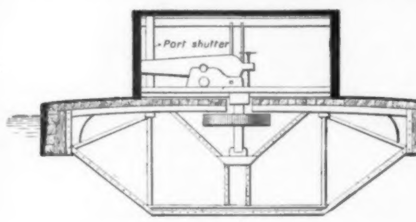
ON August 3rd, 1861, the Federal Government voted supplies for the construction of coast-service ironclads and four days later an advertisement was issued from Washington inviting competitive designs. Among those who submitted proposals was John Ericsson, and on October 4th a contract was signed by which he was intrusted with the construction of the ship which was to become famous as the "Monitor." The keel-plate of this vessel was laid at Brooklyn on October 25th, 1861; on January 30th, 1862, she was launched; and fifty years ago she was completed for sea on February 15th, 118 days from the laying of the first keel-plate.

It is customary to regard the "Monitor" as the first turret ship ever built, but as a matter of fact this distinction belongs to the Danish gunboat "Rolf Krake," which was laid down a few months before the "Monitor." However, the latter is by far the better known of the two, and she was the first vessel in which the new method of mounting guns was thoroughly and successfully tested. It is, perhaps, not generally known that Ericsson submitted the design of a vessel similar to the "Monitor" to the Emperor Napoleon at the time of the Russian war of 1854, and that the Emperor passed over the suggestion in favor of armored batteries. Capt. Cowper Coles, an English naval architect who was responsible for the design of the British turret-ship "Captain," which capsized in the Bay of Biscay in 1870, had also suggested the turret system of gun-mounting in 1860, but his suggestions differed considerably from those embodied in the "Monitor" by Ericsson the following year.

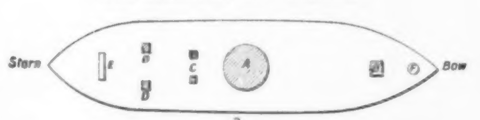


This engraving, first published in our issue of March 22nd, 1862, was drawn by the SCIENTIFIC AMERICAN artist at the Brooklyn navy yard, just before the "Monitor" sailed for Hampton Roads. Naval authorities consider it one of the most accurate representations ever published.

Ericsson's "Monitor" of 1862.



The arrangement of the armor and backing.
Cross-section of the "Monitor."



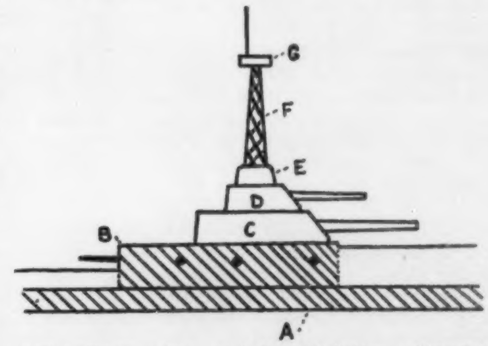
A. Turret. B. Pilot house. C. Smokestacks. D, D. Blower shafts. E. Propeller well. F. Anchor well.
Deck plan of the "Monitor."

The general appearance of this really epoch-making vessel is too well known to need lengthy description here. In many pictures, however, she is quite improperly represented as having no protuberances above the deck except the turret and the smokestack, the conning-tower (or pilot-house, as it was then called) being shown on the roof of the turret. This was, indeed, Ericsson's original idea, and it was adopted in later vessels of the type; but in the case of the "Monitor" he had no time to make the necessary arrangements, and the conning-tower was mounted well forward. A speaking-tube connected this with the turret, but it will be recalled that in the famous duel with the "Merrimac" this was severed early in the engagement, and communication had afterward to be kept up by a chain of men. Further, the "Monitor" had two smokestacks, not one. These were square, and abreast, and were capable of being stowed away when going into action. There were also two blow-hole shafts abaft the funnels.

It is rather curious to reflect that the turret-ship was heralded as the type which was to replace the so-called "broadside ship." The type of which the "Monitor" was the pattern did, indeed, replace the earlier pattern; but the strange thing is that this earlier pattern—which was partially resuscitated later—should have gone under the name of "broadside ships" at all. To all intents and purposes they were simply developments of the old frigates and three-deckers—that is to say, the broadside fire never exceeded to any considerable degree fifty per cent of the total armament. The "Monitor," of course, could fire both her guns on either broadside; and had there been time for Ericsson to erect the pilot-hous on top of the turret, they would have had an effect arc of 360 degrees when the funnels were unshipped.

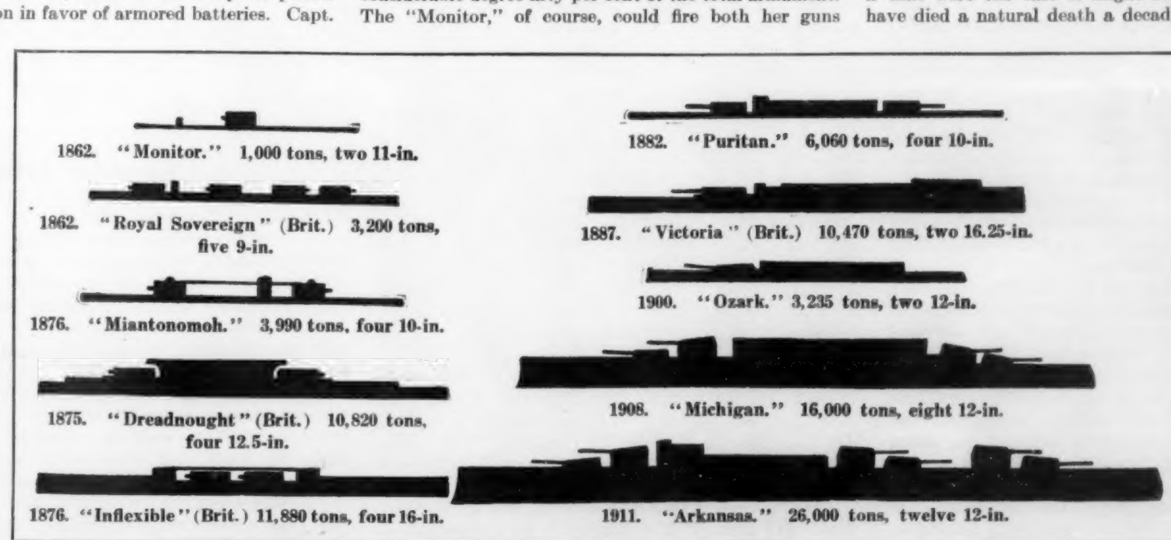
The original turret ships of the "Monitor" type were designed primarily for coastal service, and although many of them made long voyages—the "Miantonomoh" crossed the Atlantic in 10 days 18 hours, and the "Monadnock" made the journey round the Cape—this was really all they were suited for. Direct developments from Ericsson's ship continued to be built for the American Navy until the beginning of this century. The "Arkansas," "Nevada," "Florida" and "Wyoming" (now the "Ozark," "Tonopah," "Talahassee" and "Cheyenne," respectively), completed in 1902-3, are still usually classed as "coast defense monitors;" and although they are as superior to the vessel of 1862 as forty years of scientific advance could make them, they are nevertheless considerably inferior from the point of view of the fact that the superstructure aft cuts a large arc out of the angle of fire.

It is not only in coast-defense ships, however, that the influence of Ericsson's turret ship is to be traced—if that were the case it might reasonably be said to have died a natural death a decade ago. On the contrary, the most modern of the world's warships illustrate the immutability of the principles to which Ericsson gave expression, and the more recent the ship the more closely are those principles followed. The only really essential difference is that all modern armored ships are built for sea-going work, and therefore have high freeboards.



A. Water-line armor belt. B. Anti-torpedo battery (eight 3.9 in.) C. Main armament (three 14-in.) D. Secondary armament (two 7.5-in.) E. Conning tower. F. Lattice mast. G. Fire control platform. Hull armor, shaded; maximum thickness 15.7 inches. 8,200 tons. 12,600 horse-power. 22 knots.

Lorenzo d'Adda's suggestion for securing all-round fire in a motor-driven battleship.



THE TURRET SHIP FROM THE "MONITOR" OF 1862 TO THE "ARKANSAS" OF 1911

The main features of the "Monitor" design were, the heaviest possible gun, an all-round fire, efficient armor protection, and a small target. As the "Monitor" was built to fight at very short ranges, the freeboard of the guns was of no consequence; to-day, when battle ranges promise to average in the neighborhood of 10,000 yards, it is policy to raise the guns to as high a level as is compatible with stability, power to hit being of more importance than the power to avoid being hit, save in so far as immunity from damage is to be insured by damaging the enemy first.

Several Powers followed in Ericsson's footsteps by building turret ships of various patterns, and within a couple of years there had been set afloat two vessels which were a closer approach to the modern dreadnought than anything built between 1865 and 1905. These were the American "Roanoke" and the British "Royal Sovereign," described and illustrated in the SCIENTIFIC AMERICAN for November 20th, 1909, and February 19th, 1910, respectively. The former was given three and the latter four center-line turrets. In the British navy an attempt was made later to combine the turret system with full sea-going and sea-keeping qualities, but it was not altogether successful. The largest turret-ship ever built was the British "Inflexible," of 11,880 tons. This ship was launched in 1876, and carried four 16-inch 80-ton muzzle-loaders in two echeloned turrets. The heaviest gun ever mounted in a turret on shipboard was the 16.25-inch 110-ton gun. Two of these weapons were mounted in a single turret forward in the British battleships "Sans Pareil" and "Victoria," launched in 1887. Weapons of greater caliber (17.7 inches) but less weight were mounted in the old Italian battleships "Dandolo" and "Duilio." One of the most remarkable turret-ships ever built—also British—was the coast-service vessel "Hotspur," launched in 1870. It had frequently been urged that the revolving turret was liable to be put out of action by a shot damaging the turning mechanism or throwing the turntable out of truth. The "Hotspur" was, therefore, equipped with a fixed turret pierced with four large port-holes through which the single gun could be projected as required. Needless to say, it was not long before the authorities discovered the futility of this arrangement, and the fixed structure was then replaced by a revolving turret with two guns.

During the 1880 decade most of the naval Powers took a sudden dislike to the closed turret, and in its place was adopted the open-top barbette. This system had many advantages—it saved a good deal of weight and enabled the guns to be placed at a higher level than was possible with the heavily-armored turret; but, on the other hand, the breech end of the guns, and the guns' crews, were left entirely unprotected. It was curious that the introduction of the efficient quick-firing gun coincided more or less with the appearance of the open barbette, and, not unnaturally, quickly put an end to it.

The barbette, however, did not entirely disappear, but there was devised a convenient half-way house between it and the turret. This was at first known as the hooded barbette. It retained to some extent the protection which the closed turret afforded to the guns' crews, while it also had the advantage of the protected base, a feature that was missing in most of the early turret-ships. Hooded barbettes came after a time to be referred to simply as "barbettes," but it is now almost the universal custom to call them "turrets"—and they certainly have more in common with Ericsson's invention than with the open-top gun-house that may be said to have reached its climax in the British battleship "Benbow," in which a 110-ton gun was mounted on the top of a tower at either end of the superstructure.

We have thus returned to the "Monitor" ideal of a completely protected gun's crew. Just as surely we are approaching again the ideal of 360-degree arc of fire. Indeed, so far as modern tactical conditions require it, this may even be said to have been attained in all those vessels (including all the American and several foreign dreadnoughts) in which it is possible to concentrate all the heavy guns on either broadside. Nevertheless, naval authorities still seek to increase the efficiency of their ship-armaments in this direction; but it will be realized that so long as six, five, four or even two turrets are placed in different positions in a ship it will be impossible to secure a complete arc of fire from all the guns. For, even if masts and funnels are eliminated, there will always be an arc in which the fire of one turret is screened by the other, or by several others.

With this fact in mind it is interesting to refer to a suggestion recently put forward by Signor Lorenzo d'Adda, a well-known Italian naval architect. The suggestion is really a development of the idea embodied in the "New Jersey" class, but instead of only one turret being super-imposed on another the whole of the necessary protuberances above the deck are placed one on top of the other. A sketch of this arrangement is given herewith, the vessel itself being assumed to be driven by internal combustion engines.

In its essentials the turret has really changed very little in the fifty years of its life; but latterly it has shown signs of unexpected developments. The "Monitor's" turret contained two 11-inch Dahlgren guns; and it was not until August, 1910, that the first ship was launched which is to carry three guns in each turret. This was the Italian battleship "Dante Alighieri." The guns in these turrets will be mounted in the form of a triangle, two being on the lower level and the third above and between them. In addition to the "Nevada" and "Oklahoma," the triple turret has also been adopted in certain Russian and Austrian ships, but in each case it is believed the guns will be mounted abreast.

A proposal for a six-gun turret has also been put forward recently by the Italian architect already referred to. The guns project in pairs, each pair making an angle of 120 degrees with the other. The advantage claimed in this case is saving of weight and space, and rapidity of fire, since while one gun is being fired the others can be loaded and prepared. It is estimated that twelve guns mounted in this manner would demand 30 per cent less weight than if they were distributed over six turrets; and also that twelve 12-inch guns could easily be carried on a displacement of 16,000 tons.

Defects in Present Day Varnishes

Some Hints on "Reviving" Furniture

By Dr. L. V. Redman

THE author is the holder of Fellowship No. 10 of the University of Kansas and is engaged in research on the Chemical Treatment of Wood. The work is carried on under the direction of Prof. Robert Kennedy Duncan, through whose efforts a large number of industrial fellowships have been established at the universities of Kansas and Pittsburgh.—ED.

Defects in varnishes are as many as the varieties and brands for sale in the open market. Some of these defects are, hairlining, alligatoring (cracking), tackiness (stickiness), whitening under water, darkening rapidly with age, brittleness, dulling of the glossy surface, lack of toughness (being easily scratched), sweating on damp days if the temperature is high, and blistering in the heat of summer.

These defects may be more readily understood if I briefly describe the materials of which varnishes are composed. Varnishes are divided into two classes: oil and spirit. Oil varnish consists of resins, such as, Amber, Copal, Anime, Kauri, Manilla, Mastic, Dammar, Rosin, etc., dissolved in oils, such as linseed, tung, walnut, safflower, candle nut, soya bean, etc., and diluted with a thinner such as turpentine or benzine. A spirit varnish consists of resins dissolved in spirits, that is, volatile solvents, as for example turpentine, alcohol, wood alcohol, naphtha, benzine, etc. The last mentioned varnish dries rapidly as the solvent evaporates and leaves behind a film of resins which are naturally hard, glossy, brittle, easily scratched, and resistive toward water and weather. The advantages of a spirit varnish are the speed of drying, hardness and resistance to weathering. The disadvantages are brittleness, the coated surface scratching easily, and the difficulty of application, as a spirit varnish dries too rapidly and leaves brush marks.

The tough oil varnishes are in greater demand than the spirit varnishes although the defects in oil varnishes are numberless. How often a person sits on a varnished chair and on rising finds the loose nap from his clothes sticking inseparably to the chair and the print of the weave of his clothes left in the soft, tacky varnish. Cases have come within the writer's observation where the fine fabrics in ladies' dresses have been torn on being drawn from the sticky or "tacky" varnish. Cheap contract varnish, such as is often found on church pews and public benches generally, is likely to show this undesirable quality. These varnishes have incorporated in them non-volatile, non-drying oils such as the heavier mineral oils. These oils do not oxidize and dry to a solid elastic mass, as drying oils do, and as a consequence the varnishes remain "tacky" for an indefinite time and practically never dry. There is no remedy for this defect but to cut off the poor varnish with some solvent such as, one quart acetone, one quart alcohol, one-half pint of water saturated with washing soda and one quart of benzene, in which a few ounces of paraffin or other wax has been melted. The mixture should be well shaken and then brushed over the surface until the varnish is quite wet. To prevent evaporation, cover over the article with old sacks and let it stand for twenty minutes, giving time for the solution to soften up the varnish. On removing the sacks, the varnish will be found very soft and easy to wipe off with a rag or to scrape off with a straight piece of glass or steel. When the article is cleaned and wiped thoroughly dry, revarnish with a good linseed oil varnish. The receipt given above will remove any varnish whatsoever whether old and hard or soft and sticky.

Sweating of varnishes on damp warm days is due in many cases to the presence of fish oils. These oils absorb moisture which causes the varnish to become clammy and sticky to the touch, if the temperature is above 80 deg. Fahr. The presence of oils having the power of absorbing water, accounts for the excessive dews which collect on freshly varnished boats and canoes beached on an open shore of a summer's night.

Good varnished furniture is the bane of every one who possesses it. It is "so easily" scratched, and scratches cannot be mended. Scratching will never be eliminated from furniture until a harder and tougher varnish is discovered. Scratches which appear white can not be easily obliterated. They may be obscured, however, by rubbing well with a piece of cheese cloth moistened with a solution of nine parts boiled linseed oil and one part lemon oil. Any failure to have this solution work correctly will arise from the fact that too much oil has been applied to the surface and the rubbing has not been sufficient.

Whitening of varnish in the presence of water, for example on the bottom of a canoe, is due to the absorption of water by the varnish, especially those low in good resins, and may be corrected by allowing the varnish to dry thoroughly in the open air (sunlight). This treatment causes the water to evaporate and restores the original appearance of the varnish. A spar varnish (that is, one high in resins) should then be applied to the thoroughly dry surface. If the surface is not allowed to dry thoroughly before the new coat of varnish is applied "blooming" will be the result, that is to say the varnish will have a dull smoky appearance like the bloom on a ripe blue berry.

Everyone has observed minute hairlines on highly polished varnish surfaces, such as piano cases. This hairlining is the first stage in the cracking of the varnish, and as the cracks widen the surface takes on a resemblance to alligator leather. This hairlining or cracking of varnishes is caused primarily by too little oil being used in the varnish, or as varnish makers term it "a short oil varnish" has been used. The lack of oil allows the varnish to dry in a short time, perhaps not longer than eight hours, but the coating is brittle and soon hairlines and these lines in time widen into unsightly cracks. Excess of cheap resins such as rosin often causes these defects to appear in varnished surfaces.

Housewives may hasten these defects by using such cheap liquid furniture revivers as brighten good varnish for a short time by dissolving part of the resins they contain. One of the best possible furniture revivers is one which every housewife may easily mix and prepare at a cost of a few cents and with no labor whatsoever. One part of lemon oil and two parts of boiled linseed oil well mixed and applied rather sparingly to the varnished furniture with a linen rag, a piece of silk or cheese cloth, free from nap and dust, will do more to preserve good furniture than any veneer sold at the present time.

New Trans-Andine Railways

IN a few years one will probably no longer be able to speak of the trans-Andine Railway, as two other interoceanic routes over the Andes are now projected. The Ferrovia del Gran Sur Argentina has issued bonds to the value of $14,600,000 to extend its line to the Chilean frontier at San Martin de los Andes, about opposite Valdivia, from which port a line is now building that will ultimately connect up with the Argentine line. Farther north the Chilean government has had a corps of engineers at work for a year, seeking a favorable route for another trans-Andine line, and one has been found between the headwaters of the Maule River in Chile and Colorado River in Argentina. Both the proposed lines will offer the advantage over the present route that they will cross the mountains at a much lower altitude (5,000 feet, as compared with 10,000 by the existing line).

The "Great Storm" of 1703

An Historic Meteorological Event

By Charles Fitzhugh Talman, Librarian of the United States Weather Bureau

OF the unnumbered storms that have buffeted our earth, many that interest the ordinary historian hardly fall within the outlook of the historian of science.

The simoon that overwhelmed Cambyses' army of fifty thousand men in the Libyan desert is historic. So is the tempest that strewed the Scotch and Irish coasts with the wreckage of the Spanish Armada; in memory whereof the English Queen caused to be struck a medal showing a storm-tossed fleet, with the legend: *Afflavit Deus et dissipantur.* So is the great gale that coincided ominously with the death of Cromwell. All of these storms, however, are too meagerly known from the point of view of physical science to hold important places in scientific annals.

The "Great Storm" of November, 1703, which is reputed to have been the most disastrous atmospheric visitation from which England has ever suffered, and which raged with little less severity over many other parts of Europe, occurred long before the days of weather bureaux and synoptic meteorological charts; yet we are able to-day to piece together, from various contemporary descriptions, a tolerable account of its topography and history.

The Great Storm bulks large in English literature, compared with other occurrences of kindred nature. Defoe wrote an unacknowledged book about it, entitled, "The Storm; or, a Collection of the most Remarkable Casualties and Disasters which happen'd in the Late Dreadful Tempest, both by Sea and Land" (London, 1704); while Addison's allusion to it in his "Campaign"—

So, when an angel by divine command,
With rising tempests shakes a guilty land,
Such as of late o'er pale Britannia past—

is one of the well-worn passages of English poetry. Its effect upon the popular imagination of the time was prodigious. Defoe no doubt expressed the universal conviction of his contemporaries in calling it "the most violent tempest the world ever saw."

Statistics of the damage wrought by the storm are conflicting, but all writers of the period agree that throughout the south and west of England the destructive effects of the wind were quite without precedent. Defoe sums them up as follows: Twenty-five parks lost over 1,000 trees apiece, while in the New Forest over 4,000 were blown down; the leaden roofs were stripped from a hundred churches; over 400 windmills were destroyed, part being blown down, and part set on fire by the rapid revolution of the sails; seven steeples were blown down; over 800 dwelling-houses were laid in ruins; 123 persons were killed on land, and hundreds more injured.

At sea the loss of life was far greater; a succession of gales preceding the principal storm had crowded the harbors and roadsteads with vessels, and these were driven ashore by the hundred. Over eight thousand seamen are said to have perished, including some 1,500 men of the Royal Navy—the heaviest loss of life that service has ever experienced in so brief a period, whether in war or peace. One of the victims was Rear-Admiral Beaumont, whose flagship, the "Mary," foundered in the Downs with the loss of all but one of her 273 men. In the same perilous roadstead the "Northumberland" and the "Restoration" went down with all hands, while the "Stirling Castle" was driven on the Goodwins and lost half her crew.

The history of the Great Storm abounds in picturesque and dramatic episodes. One of these was the rescue of two hundred seamen from the Goodwin Sands. Several vessels were stranded here at low tide, and their men could be plainly seen from Deal, walking about on the sands or clinging to the wreckage, signaling for assistance before the rising waters should ingulf them. Their appeals were not heeded at first, for the boatmen of Deal were only concerned with gathering the booty that the sea had brought them, and cared nothing for the lives of the wretched sailors. It was an age in which shipwrecks were an important source of revenue to dwellers on the British coasts, and the professional wrecker still flourished. Only one man was moved to pity—Thomas Powell, mayor of Deal, a humble slop-seller by trade. Powell first appealed to the custom-house authorities, who refused to send out their boats upon an errand of mercy; then he called a number of citizens about him, and by an offer of five shillings a head for all who should be saved from the wrecks succeeded in enlisting a numerous party of rescuers. He next proceeded to seize by force the custom-house boats, as well as several other boats that were being used in gathering plunder, and thus equipped he brought ashore as many of the unfortunate sailors as possible, though hundreds perished before they could be reached. These he fed and lodged at his own charge, as the Queen's Agent for Sick and Wounded Seamen declined to do anything for them. The next day several died, and were buried—again at the expense of the magnanimous mayor—and the rest he provided with the means of reaching London. Long afterward he was reimbursed by the Government for the expense thus incurred; but his noble conduct deserves none the less to be recorded imperishably in the catalogue of golden deeds.

Another striking episode of the storm was the destruction of the first Eddystone lighthouse. Its architect, Winstanley, was a retired mercer, who spent his leisure in devising mechanical toys, with which he filled his house at Littlebury, in Sussex. The lighthouse was, however, the achievement in which he took most pride. This building was much better adapted to adorn a tea-garden than to crown a desolate rock exposed to the full force of the Atlantic breakers; it was constructed chiefly of wood; its ground plan was polygonal, so that it offered great obstruction to the waves; and it was loaded down with a quantity of fantastic and useless ornaments. Besides accommodations for the keepers, the edifice contained the private apartments of the builder, including a splendid bedchamber, richly gilded and painted. The contriver of this extraordinary monument had such fatuous confidence in its stability that he expressed the hope of being in it during the worst gale it should ever experience. This wish was tragically accomplished. The day before the storm he visited the lighthouse to superintend some repairs. As he put off from Plymouth Quay he was warned by an old sailor that a dreadful storm was brewing, but he disregarded the warning. At nightfall the lighthouse was seen standing, from Plymouth Hoe; when another morning broke it had vanished, with its eight occupants.

The falling of chimney-stacks caused great damage to dwelling houses and cost many lives in various parts of the Kingdom. In this manner appear to have perished Bishop Kidder (who had supplanted the non-juring Thomas Ken in the see of Bath and Wells) and his wife; though accounts differ as to the particulars of their death.

The total loss of property occasioned by this storm in London alone was rated at over two million sterling, and throughout the country at nearly five millions. Defoe considered it a more serious calamity than the great fire of 1666. On the 19th of January following the national disaster was made the occasion of a day of public fast and humiliation; the Lords attended a special service in Westminster Abbey, and the Commons one in St. Margaret's Church.

Such were some of the results of the Great Storm of 1703. Turning now to the meteorological aspects of the storm, we find that Defoe's narrative, though a curious mixture of history and crude speculation, is noteworthy from a scientific point of view for at least two reasons; it includes an enumeration, in tabular form, of the nautical expressions denoting successive gradations of wind-force—thus anticipating Admiral Beaufort by a hundred years—and it contains what is probably the first attempt to trace the path of a storm over a wide area of the earth's surface. Defoe's wind-scale, which is probably unknown to most meteorologists, runs as follows:

Stark calm	A topsail gale
Calm weather	Blows fresh
Little wind	A hard gale of wind
A fine breeze	A fret of wind
A small gale	A storm
A fresh gale	A tempest.

The earliest anemometer had been invented some forty years before, but appears to have been little used or known at the time, judging from the following interesting attempt on the part of Rev. William Derham, F.R.S., to express the violence of the Great Storm on a numerical scale. We quote from his memoir in the *Philosophical Transactions*, 1704:

"The degrees of the wind's strength not being measurable, but by guess, I thus determined with respect to other storms: On February 7th, 1699, was a terrible storm that did much damage; this I number 10 degrees. Another remarkable storm was February 3rd, 1702, at which time was the greatest descent of the mercury ever known; this I number 9 degrees. But this last of November I number at least 15 degrees."

Defoe's account of the storm's path is remarkable, when we consider that it was written more than a century before anything was certainly known regarding the life-histories of storms in general. He places its origin in America, where a tempest was reported to have been felt a few days before the date—November 26th and 27th (O. S.)—on which the storm reached its height in England. Of its further history he says: "It carried a true Line clear over the Continent of Europe, traversed England, France, Germany, the Baltick Sea, and passing the Northern Continent of Sweedland, Finland, Muscovy, and part of Tartary, must at last lose itself in the vast Northern Ocean . . . and in this Circle of Fury it might find its End not far off from where it had its Beginning."

The idea of thus following the progress of a storm from day to day over the earth's surface belongs rather to the nineteenth century than to the beginning of the eighteenth. Had some one but gone an easy step farther, and compared the directions of the wind at a number of places and at a given time with the general direction of the storm's movement, one of the fundamental discoveries of meteorology would have been anticipated by about one hundred and twenty years.

It remained for a meteorologist of our own times, Mr. Henry Harries, of the British Meteorological Office, to put together a great number of contemporary records to which Defoe did not have access, and to give us the first scientific account of the Great Storm.* It appears that meteorological observations had, at the period in question, been registered in England for many years and forwarded to the Royal Society; but as that body did not realize that they might be of interest to posterity they were destroyed as "useless." Under these circumstances it occurred to Mr. Harries that it might be worth while to make an examination of the log-books of the English men-of-war that escaped destruction in the storm, these old documents being still preserved in the Public Record Office. A surprising amount of pertinent information was thus obtained. The logs of no less than 136 vessels of the navy were found to contain reports of wind and weather within the basin of the North Atlantic for the month of November, 1703. Barometric data was lacking since neither barometers nor any other forms of meteorological apparatus were carried on shipboard at that time. The vessels were, furthermore, unfortunately distributed for the purpose of this investigation; the great majority were in home waters or on the Dutch coast, while west of Ireland the ocean was clear of shipping; so that the march of the storm across the Atlantic could not be determined.

It is impossible to confirm Defoe's opinion that the storm reported in America a few days before the 26th was identical with the Great Storm, though such may well have been the case. When the cyclone reached Europe it was as remarkable for its extent as for its violence. Reports from the Tyne and from Copenhagen, the most northerly points from which observations are available, show that the storm center passed well to the northward of these localities, yet the fury of the gale extended as far south as the Mediterranean.

The worst of the storm was doubtless felt in England, over which it traveled from west to east at the rate of about fifty miles an hour. This statement refers to the translation of the storm as a whole, not to the velocity of the wind. The latter can only be conjectured; judging from its effects it must have been altogether comparable to that experienced in the hurricanes or typhoons of the tropics.

Comparing this storm with other general cyclones—distinguished from tropical hurricanes and tornadoes—it appears to have been the most violent of which history holds any record.

The Oldest Lighthouse Extant

AT La Coruña in Northern Spain may be seen a fire-tower which is, with the exception of the ruins of the Roman lighthouse at Dover, the oldest of all existing structures of this kind. The exact date of the erection of this tower is unknown. According to an ancient tradition, it is accredited to Hercules, whence its name Torre de Hercules. Others say that Phoenicians who had established several colonies in Spain, had erected this light-tower for their northland cruises. However, judging from the inscription, it is more probable that the Roman Emperor Trajan (98 to 117 A. D.) erected this structure. The inscription also mentions the name of Servius Supus of Lusitania as the architect. The tower is built of ashlars and is 9 meters square and 40 meters in height. It has six separate stories which can only be reached by a circular staircase around the exterior of the tower. The lighthouse was restored in 1684, but at the end of the eighteenth century was again in ruins. In 1797 it was rebuilt by the Spanish government, and still sends forth its beams.

* *Cornhill Magazine*, new series, vol. 3, 1897, pp. 579–593.

The Mount Wilson Solar Observatory

Studying the Heavens With the Most Elaborate Equipment in the World

By Dr. E. A. Fath, of the Staff of the Mount Wilson Observatory

THE problem of modern astronomy is to determine the structure of, and the laws governing, the physical universe. This stupendous problem is being attacked at many points by the various observatories. Mathematics, physics, chemistry and geology are called upon to contribute all possible assistance toward its ultimate solution. To aid in this solution, primarily from the physical standpoint, the Mount Wilson Solar Observatory was established as one of the departments of research of the Carnegie Institution of Washington. The observatory is located on the summit of Mount Wilson, near Pasadena, California, at an elevation of approximately 5,900 feet above sea-level. This site was chosen as the most suitable after a careful investigation of possible locations throughout the country.

In order to study the stars in general it is necessary to study first those nearest at hand. The sun being nearly 300,000 times nearer us than any other known star was naturally chosen as the primary object of investigation. A detailed study of solar phenomena is therefore being made. The ultimate object of this is to apply the knowledge thus obtained to the vastly greater problem, the evolution of our stellar system, of which the sun is a member. To this end daily photographs of the sun are taken, some to show the general features of the surface, which is continually changing; others, by means of a spectroheliograph, to show the distribution of various gases and vapors in the solar atmosphere; and still others to show the distribution of prominences around the edge of the sun's disk. This routine observing is being carried on mainly with the Snow horizontal reflecting telescope of 24 inches aperture and 60 feet focus. This instrument, the first permanent one of the observatory, was set up in 1904. It produced and is still producing results of the greatest value, nevertheless it was felt that better work could be accomplished by eliminating as far as possible certain sources of trouble. These were: (1) Poor definition of the image during long exposures, owing to the distortion of the mirrors by the heat of the sun. (2) The possible stratification of the air along the horizontal beam of light. (3) Changes of temperature in spectrograph and spectroheliograph.

Careful consideration of these various points finally led to the erection of the 60-foot tower telescope in 1907. The mirrors of the coelostat were made 12 inches thick instead of 4 inches as in the Snow telescope, so that their distortion became negligible. The beam of light was sent vertically downward through a 12-inch lens to eliminate the effect of possible horizontal air strata. The spectrograph and spectroheliograph are placed in a vertical position in a well 30 feet deep in which the temperature changes less than 4 deg. F. from summer to winter. The depth of the well permits the use of a focal length of 30 feet, thus greatly increasing the scale over the 5-foot focus instrument used with the Snow telescope. The vertical position is also of especial advantage in eliminating flexure in the instruments.

The results obtained with this instrument have abundantly justified its unique construction. Some of these may be briefly enumerated. The origins of large groups of lines in the solar spectrum have been traced to various compounds. The low-lying vapors in the sun's atmosphere are found to rotate more rapidly near the equator than at higher latitudes, while the greater the elevation of the vapors the less the variation of the rotation period with latitude. Evidence has been adduced that the general temperature of sun-spots is lower than that of the remainder of the solar surface. The "flash" spectrum has been photographed without an eclipse of the sun. The detection of the Zeeman effect in sun-spots. This last is undoubtedly the most important of all.

Fig. 1.—A view from the north showing the dome of the 60-inch reflector, the 60-foot tower telescope, the Snow horizontal telescope beyond and to the right of this tower, and at the extreme right the new 150-foot tower.

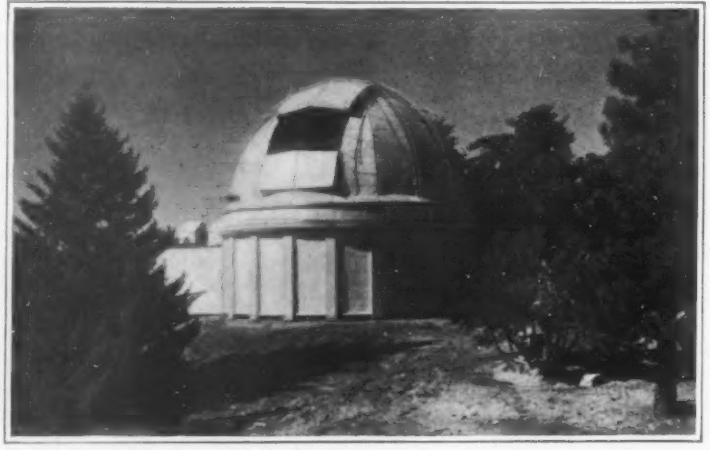


Fig. 2.—The dome of the 60-inch reflector.

The image of the sun formed by the Snow and 60-foot tower telescopes is about 6.7 inches in diameter. While this is ample for some purposes, yet many features of the solar surface, to be studied to good advantage, demand a larger image. The tower telescope has proved such a success that a larger one of the same type 150 feet in height with an 80-foot well beneath was constructed during the summers of 1909 and 1910. The solar image formed by this instrument will be 17.5 inches in diameter, thus permitting the study of much finer detail on the sun's surface than heretofore. The optical parts of this telescope are not yet in place but it is hoped to have it in operation before next summer.

The spectrograph and spectroheliograph of the new tower telescope are of 75 feet focus, thus again greatly increasing the scale of the spectra. They are of course to be placed in the well beneath the tower just as in the case of the first instrument of this type. It does not seem unreasonable to expect that this increase in size, with the advantages accruing therefrom, will correspondingly increase our knowledge of solar physics.

The various telescopes thus far considered have made possible the study of many solar phenomena of great importance, but as is often the case one may be able to arrange the various facts in orderly fashion without fully comprehending the underlying causes. It is therefore of vital importance to know just how various lines in the spectra of the elements behave under changes of temperature and pressure and in the magnetic field. Accordingly a physical laboratory has been established in Pasa-

Fig. 3.—The 60-foot tower and Snow horizontal telescope.

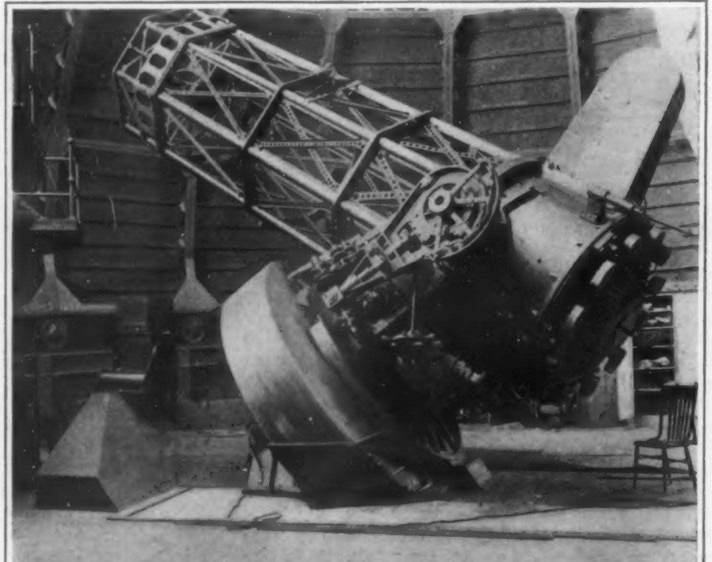


Fig. 4.—The 60-inch reflector.

THE MOUNT WILSON SOLAR OBSERVATORY

dena, where special studies to this end are undertaken. The laboratory is equipped with an electric furnace of special design to permit the study of the effect upon radiating vapors of various temperatures up to about 5,500 deg. F. The furnace can also be placed under pressures varying from a high vacuum to 3,000 pounds per square inch. Thus the effect of the simultaneous variation of both temperature and pressure can be obtained. The laboratory is further equipped with pressure chambers to permit the study of arc and spark spectra under pressure. There are also two powerful electro-magnets for the investigation of the Zeeman effect. Most of these researches are carried on by means of two large Littrow spectrographs, one of 13 and the other of 30 feet focus. These spectrographs, just like those of the tower telescopes on the mountain, are placed vertically within a well 30 feet in depth beneath the laboratory floor.

A good illustration of the co-ordination of solar and laboratory research may be cited in connection with the discovery of the Zeeman effect in sun-spots. The lines of certain elements in the spectra of sun-spots were found to be doubled or tripled. These same elements were investigated in the laboratory, the source of light being placed in a powerful magnetic field as originally done by Prof. Zeeman. The behavior of these lines under laboratory conditions on the whole agreed so well with their behavior in the spots that there could be no reasonable room for doubt that the sun-spot is the seat of a magnetic field which causes the above-mentioned effects in the spot spectrum.

But while this work on the sun has been continued, and the results obtained might in all justice be taken as the end sought, yet this work can be regarded as only the foundation upon which the vastly greater superstructure is expected to rest. For the study of the more distant parts of the physical universe the 60-inch reflecting telescope, completed in 1908, is available. It is devoted to the spectrographic investigation of the stars and nebulæ as well as to obtain direct photographs of them. By means of auxiliary mirrors the primary focal length (25 feet) of the 60-inch mirror can be changed to 80, 100, or 150 feet. Direct photographs can be taken either at the 25-foot focus or with the 100-foot combination, while various spectrographs are available for use with 25-, 80- or 150-foot combinations. The great light-gathering power of this telescope enables correspondingly fainter stars to be studied, and its focal length being greater than in modern reflectors, much more detail can be photographed in objects such as nebulæ.

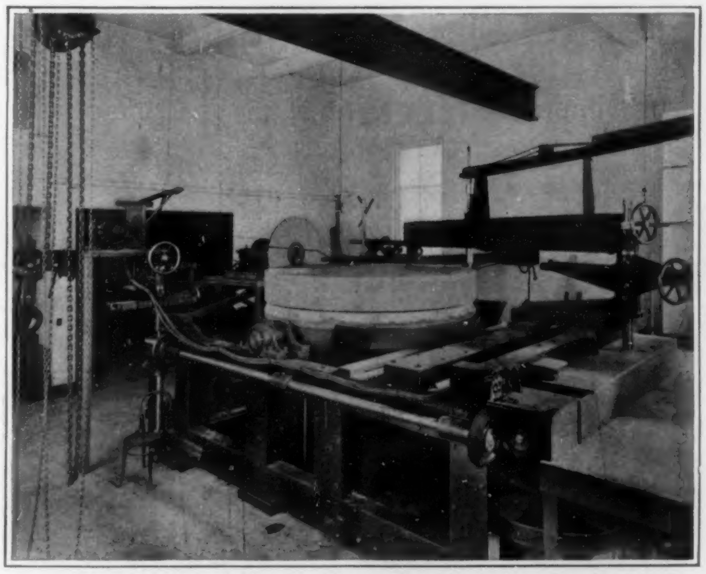


Fig. 5.—Large grinding machine in the optical shop, Pasadena.

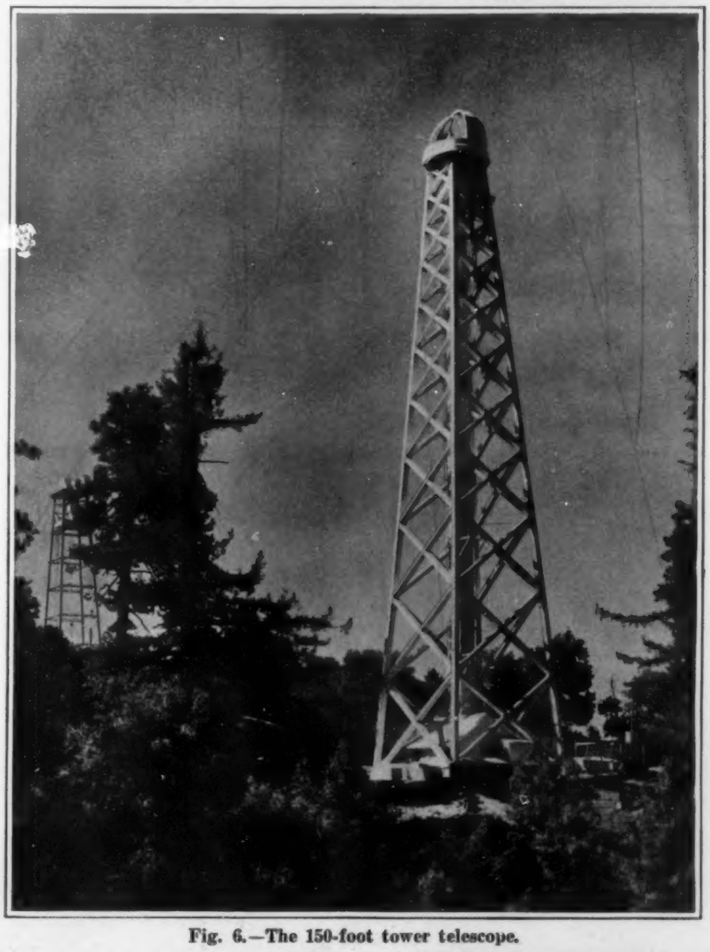


Fig. 6.—The 150-foot tower telescope.

Some of the results obtained with this instrument in the two and one half years it has been in operation are the following: Evidence has been adduced that the vapors of certain elements producing absorption lines in the spectrum of Sirius are under a pressure 12 atmospheres greater than the same vapors in the sun. In Procyon the pressure is 7 atmospheres greater while in Arcturus the pressure is equal to the solar pressure. It is possible to get radial velocities of stars as faint as 8.5 photographic magnitude with ordinary exposures. The integrated spectra of the globular star clusters are similar, being of the F type in the Harvard classification. A number of the spiral nebulæ give spectra like our sun. The famous Hercules cluster has been shown to consist of at least 54,000 stars. A great amount of hitherto unknown detail has been photographed in the spiral nebulæ. These nebulæ have also been shown to contain many nebulous stars, while the stars in irregular nebulæ such as the great one in Orion are not nebulous.

While these investigations have been going on, the problem of the possible absorption of light in interstellar space is being attacked, but no conclusions have been reached up to the present. Photometric and parallax work have also been started.

As can be readily imagined, the number of investigations being carried on with this single instrument permits but little time for each. More telescopes are needed. It is expected that this need will be met in part by the great 100-inch reflector now in process of construction but its completion can hardly be expected in less than two years. In the meantime the 60-inch must carry the entire burden.

The transportation of building material and supplies from Pasadena to the summit of the mountain has always been a matter of more or less difficulty. From the beginning of work on the summit in 1904 up to 1907, practically everything was carried by means of pack animals over the mountain trails. As no timber over 8 feet in length could be taken in this way, the difficulty of erecting buildings can readily be imagined. Some heavy castings, however, could not be carried by the animals, so a specially designed truck was made that could be used on the trail. As the trail had many sharp turns, in some places a 20 per cent grade, and at some points a width only a trifle over two feet, the transportation of these heavier parts was no easy undertaking. In 1907 a new difficulty presented itself. This was the transportation to the summit of the structural steel for the dome of the 60-inch reflector and also the large castings forming part

(Concluded on page 164.)

Fig. 7.—Interior of the physical laboratory.

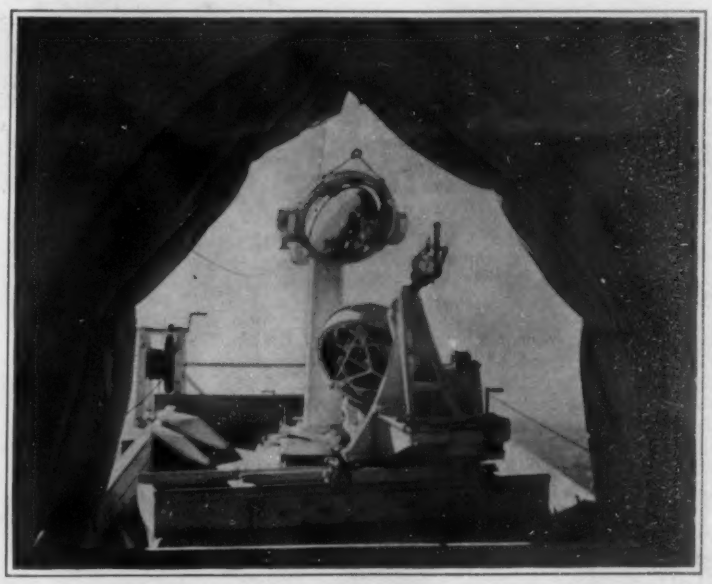


Fig. 8.—The coelostat and secondary mirrors of the Snow telescope.

THE MOUNT WILSON SOLAR OBSERVATORY

How Railroad Men are Made

Training the Men Who Run Big Railways

By P. Harvey Middleton

IN 1912, with our railroads forming a gigantic network of 240,000 miles, representing an investment of twenty-two billions of dollars, earning for their owners over a billion dollars every year, carrying a billion passengers and two billions of tons of freight in the twelve months, necessitating the employment of 1,700,000 persons—more than twelve times the combined strength of our army and navy—the requirements of railroad men of all grades, from track walker up to president are exacting in the extreme. Professional training, a clear head, steady nerves, and strong muscles are some of the requisites, but training is the most important of all. The old style of railroad man who could not read a blue print or make a free-hand sketch, would be as useless a cog in the mighty wheels of our transportation system as the superb courage of the Mahdi's troops was when opposed to discipline and breechloaders.

From this it may be seen that the education of apprentices on a twentieth century railroad is the most important problem of the company. Just as the United States Government has a West Point and an Annapolis for the training of its future admirals and generals, so our great railroad systems all have training schools for the production of educated workmen, foremen, and superintendents—academies where the raw recruit is initiated into all the mysteries of railroading, from the making of drawings to the assembling of locomotives, which later grow before his eyes from nondescript heaps of metal and pass out into active service. He helps to build these leviathans of the rails, and to repair them when they come limping back, strained from overwork or torn to pieces by collision.

Let us follow the various stages in the career of one of these novices during his four years apprenticeship in Railroadville. We will call him William Smith. He has applied to the general manager of the road, John Brown, for admission as an apprentice. Brown sees that he is an intelligent-looking chap and cross-examines him as to his mental and moral fitness.

"We have two grades of apprentices," says Brown; "special and regular—all of whom stay here three years. The boy with a public school education is drafted into the regular class, to train for the rank and file. The special must be a college graduate, and qualify for the higher positions. Take my advice, Smith, graduate from your college, and we will admit you as a special. But remember this; it is four years of solid hard work and precious little play. Ten hours a day, 304 days a year, you will have to work in the shops. You will work under the superintendent of the motive power department, and do whatever he orders—crawl into the warm fireboxes of locomotives, sweat in the glare of a white-hot furnace, wield a hammer in the ear-splitting din of the boiler-room, or paint the interior of a parlor car. It's all in the day's work. The reward? Well, it depends on your ability. The salaries of railroad men range all the way from $500 to $50,000 a year. When you have had your training, it's up to you."

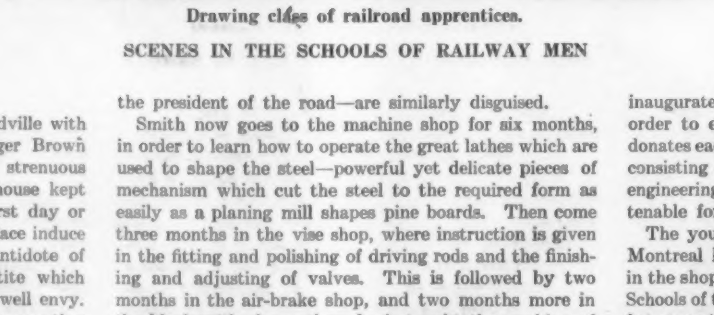
"I'll come when I graduate next year," replies Smith, quickly.

And a year later Smith gets out at Railroadville with his grip. That preliminary talk with Manager Brown has prepared him somewhat for the simple strenuous life He hires a small room in a boarding house kept by the widow of a railroad man. For the first day or so the meals and the drab atmosphere of the place induce a severe attack of homesickness. But the antidote of hard work soon replaces that with an appetite which the *habitué* of the foremost restaurants might well envy.

On his first week in the shop he is sent to the erecting room, where he studies the different parts of a locomotive and is taught the work they perform. When he has proved that he has thoroughly absorbed this knowledge, an old hand takes him inside a defective boiler, and under the experienced man's direction he repairs it. After six months of this sort of work his hands have become so rough and calloused, and his general appearance so dusty and grimy, that it is hardly probable that the girls back home would recognize their dancing partner in this hardy son of toil; and his fellow apprentices in the special class—one a senator's son, another the son of the president of the road—are similarly disguised.

Railroad employees are taught first aid to the injured.

Apprentices in instruction car learning the mechanism of air brakes, steam heating and safety appliances.



Drawing class of railroad apprentices.

SCENES IN THE SCHOOLS OF RAILWAY MEN

Smith now goes to the machine shop for six months, in order to learn how to operate the great lathes which are used to shape the steel—powerful yet delicate pieces of mechanism which cut the steel to the required form as easily as a planing mill shapes pine boards. Then come three months in the vise shop, where instruction is given in the fitting and polishing of driving rods and the finishing and adjusting of valves. This is followed by two months in the air-brake shop, and two months more in the blacksmith shop, where he is taught the working of the big steam hammers, the heavy sledges, and the giant forges.

A course of two months in the foundries, casting and molding, is followed by two months in the boiler shop—and this latter is the most trying period of his apprenticeship; for he is called upon to work amid the din of hundreds of hammers smashing against the iron ribs of great boilers, a deafening and distracting turmoil which results in some sleepless nights for Smith until he becomes accustomed to it—as he soon does.

The next class room in this strenuous schooling is the car department, where four months are spent in the freight shop and two in the passenger car shops, where Smith thoroughly masters the building of everything on rails, from a hand car to a Pullman. Then come four months in the roundhouse—the garage of the railroad—where locomotives in active service come in between the runs to be inspected and cleaned. Then Smith's apparently endless mechanical training is brought to a close by three months' duty as fireman on the road.

Now for the final year, to be spent in the cleaner but none the less strenuous business departments. Shedding his jumper and overalls, Smith enters the office of the shop clerk, and for two months he studies the ordering and distributing of supplies. Graduating from this, he places himself at the disposal of the motive power clerk for another two months, learning the elaborate system by which locomotives are built and dispatched to the various important points.

Five months must now be spent in the testing room, where he watches the railroad chemist testing the steel alloy used in the construction of axles, tires, boiler plates, and frame plates. His apprenticeship winds up with three months in the drawing room, and Smith becomes the proud owner of an honestly won diploma, which enables him to obtain an executive position from which he can climb to the highest salary in the gift of the road. He is a railroad man in the truest sense of the word, of the stuff that presidents are made of.

Where are these railroad academies? Well, the Pennsylvania Railroad has one at Altoona, Pa., the Santa Fé system has twenty-four schools, the New York Central has schools in nine of its shops in the United States and one in Canada. The Grand Trunk, Erie, D. L. &. W., D. & H., Jersey Central, and Chicago Great Western all have similar schools.

The Union Pacific has a very extensive educational system. In addition to the correspondence work, a station training school has been established at Omaha to prepare men to enter the station service of the company. This station school is equipped similarly in all respects to a regular station of medium size, and is under the direction of one of the company's experienced agents. All men entering station service on the system are required to pass through this station training school before being employed.

In the regular classes applicants are required to state their previous education and experience; whether they are subscribers to any technical magazine; whether enrolled with any correspondence school; in what line of work they wish to advance; and to what position (in reason) they are ambitious to attain.

The Canadian Pacific, at its Angus works in Montreal, has also recently inaugurated a new system of training employees; and in order to encourage deserving apprentices, the company donates each year a scholarship to the best ten apprentices, consisting of complete courses in mechanical or electrical engineering. The railroad also awards two scholarships, tenable for four years at McGill University, Montreal.

The young clerks in the general and other offices at Montreal have equal opportunities with the apprentices in the shops for equipping themselves for their life work. Schools of telegraphy and shorthand have been in operation for some time, and the advantages they offer are being eagerly seized by a number of ambitious youths. There are two terms each year, and the classes meet three evenings a week, when the students of telegraphy are instructed in the mysteries of the key, taught how to dispatch trains, etc.

The Self-scoring Target

A Device by Which Rifle Practice is Made Popular

THE army and navy are provided with the Springfield rifle, a shoulder piece which is believed to be the most effective weapon of its kind in the world. Its high muzzle velocity of 2,700 feet per second means a low flat trajectory, a wide danger space, and general accuracy of fire at all ranges. But the finest weapon becomes ineffective in unskilled hands, and if the Springfield rifle is to do the good work of which it is capable, both our seamen and soldiers must perfect themselves by thorough and intelligent practice on the target range.

The experience of the navy in target practice with big guns has shown that the best way to render efficient marksmen is to make target practice popular. A most effective way to do this (as experience has proved) is to make it possible for the men to see exactly what they are doing at the target and give them an opportunity to correct their aim as successive shots are fired. The psychological side of rifle practice and target shooting is one of the most important elements in the problem of making good marksmen. It is highly important that the gun-pointer in his turret or the rifleman on the range should be able to see how he is shooting, as each shot is fired, and the more quickly and the more clearly he can do this the more interested he will become in his work, and the more accurate will be his marksmanship.

Of late years much thought and effort have been directed to making rifle practice popular and introducing the element of interest which has too often been wanting. Improvements have been in the direction of what has been known as self-recording or self-scoring targets, in which the "marker" with his crude system of indicating the point of impact of the bullet is replaced by some sort of visual indication placed close to the rifleman. The accompanying illustrations show a very successful self-scoring tar- which has been designed by Lieut.-Commander Mark St. C. Ellis, an ordnance officer of the United States Navy.

The mechanism is exceedingly simple, consisting of a number of designating plates made of special treatment Vanadium steel, cut to the size and shape of the target. These plates are guaranteed to stand the impact of the new Springfield bullet indefinitely. It was found that the unhardened steel plate, one inch thick, would not withstand the new Springfield bullet; whereas this special plate, of only half that thickness, will endure the impact indefinitely.

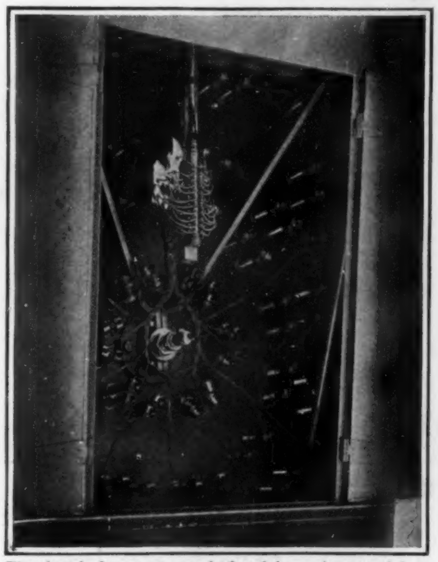
These designating plates are suspended from a central holding spindle by steel radial springs. Back of the designating plates and protected thereby is a steel shuttle board which holds the contact-making members. The action of the target when struck by the bullet is as follows: The plate which is hit yields slightly against its springs, thus taking up the powerful blow, while the contact-making shuttle, which normally touches the rear of the plate, flies backward against the tension of a weak spiral spring and completes the electric circuit, making a prolonged contact. The electric circuit thus completed, passes through appropriate cables and actuates an annunciator made up as a replica of the target itself; this annunciator is set in close proximity to the firer. Each designating plate on the target has its corresponding section on the annunciator. When a particular plate is struck a white drop with a black number falls into a hole in the corresponding section at the firing line. The man who is firing can thus tell, even before the report of the impact of his bullet reaches him, where it has struck the target. An electric set-back returns the drop to its original position at the will of the operator and the target is thus ready for the next shot. A battery of 24 volts furnishes the electricity.

The target is portable and does away with pits, tunneling and expensive range construction. Even waste land can be used for range, making it possible for small organizations to own a target and rent the land for stated periods. In fact it can be transported from one town to another, and several companies can thus use the same target, or a man-of-war can carry the targets on board and set them up on shore in a short time for practice, thus obviating the necessity for visiting a regular target range.

As there are no men employed as markers, all danger is eliminated, and persons who like to shoot can go out alone or in small groups outside of working hours and enjoy small-arms practice. One can shoot alone as well as with a squad and all that is necessary to do is to throw in the switch and go ahead. There is nothing about the mechanism that can get out of order. All the working parts are completely incased in a sheet-iron housing making it necessary to have only a covered firing point to use it in all kinds of weather. If desired, a screen, as shown in the illustration, may be placed in front of and out of the spatter zone of the target.

During the past nine months a target of this type has been in constant service at the Mare Island Navy Yard, San Francisco, where it has shown such good results that it has been ordered purchased by the Navy Department. A duplicate of the target shown in our illustrations has been hit over 200,000 times with the new Springfield rifle, the striking energy of whose bullet at 200 yards is 1,678 foot-pounds. This is a pretty severe test, and it is interesting to note that the target shows to-day no signs of deterioration.

As regards the effect of quick reading of results in popularizing rifle practice, we note that a divisional officer from one of the ships on the Pacific coast has stated that the marksmen whom he took to the range for rifle practice were keen to fire at the target, when not otherwise employed, with the result that, during the three days this division was on the range, the target was in constant use.



The electrical contacts are inclosed in a sheet-steel box back of the target. Cables lead to the annunciator at the firing line.
Rear view of target.

Target consists of independent plates of steel, which, as they are struck, spring back and make electrical contacts which register on the annunciator.
The target with screen in front.

To the right of the officer is the annunciator—a replica of the target—on which a drop, electrically operated from the target, shows instantly the score made.
INSTRUCTING A SQUAD OF SEAMEN WITH THE SELF-SCORING TARGET

Poison in Mushrooms

THE poisonous substances in some of the mushrooms or "toadstools" are known chiefly by their physiological effects. This is in marked contrast to our knowledge of poisonous substances in other groups of plants. The alkaloids found in many families of seed-plants are the best known of these vegetable poisons, on the chemical side. Among the more common are morphine, nicotine, atropine, and aconitine. Other poisonous substances found in seed plants belong to the group of compounds called "glucosides," of which digitaline is a well-known example.

The poison of the "fly amanita" (*Amanita muscaria*) is also an alkaloid, "muscarin." But the corresponding substance in the "deadly amanita" (*Amanita phalloides*) has entirely different properties and cannot be separated from the fungus by the same methods. Other mushrooms have produced sickness and death, but the chemistry of the active principle in these forms has not been worked out.

Two years ago members of the household of Dr. W. C. Deming showed symptoms of acute poisoning that were traced to the eating of some mushrooms belonging to the species *Inocybe infida*. Among the symptoms were nausea, very much increased heart action, dizziness, pain in the abdomen and profuse sweating. At the suggestion of Prof. W. J. Gies, director of the Laboratory of Biological Chemistry, Columbia University, Messrs. Ernest D. Clark and John L. Kantor undertook to isolate the poison from this fungus and to find out its characters.

It was possible to make extracts containing the fungus poison, which is similar in some respects to muscarin, though different in its effects upon frogs which were used for the physiological experiments. Extracts of the fly amanita were fatal in strengths that produced only prolonged lethargy, with eventual recovery, in the case of extracts of the Inocybe.

Muscarin acts directly upon the nervous system; the poison of the deadly amanita acts upon the blood, dissolving the red corpuscles. Atropin has been successfully used as an antidote to muscarin; there is no known antidote for the blood-laking poison of *Amanita phalloides*. Both poisons resist the action of heat.

What Inventors Are Doing

Simple Patent Law; Patent Office News; Inventions New and Interesting

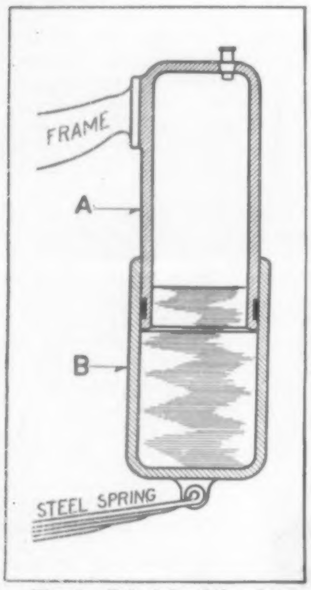


Fig. 1.—Principle of the air-spring.

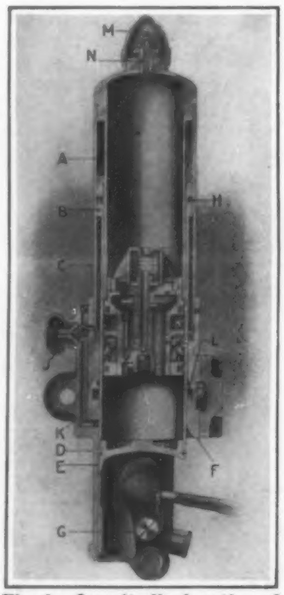


Fig. 2.—Longitudinal section of air-spring.

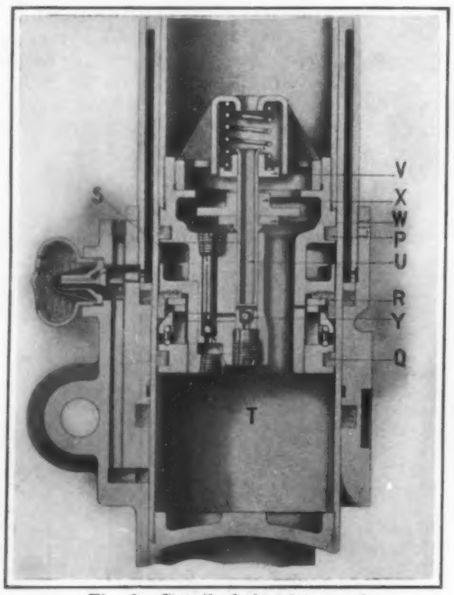


Fig. 3.—Detail of the piston and oil pump.

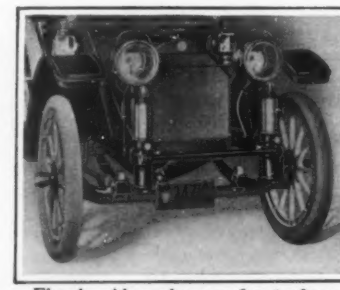


Fig. 4.—Air-springs on front of car.

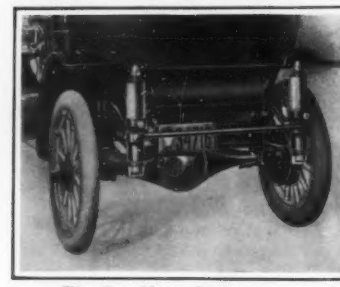


Fig. 5.—Air-springs on rear of car.

George Westinghouse's Automobile Air-spring

A New Way of Suspending a Motor-car

GEORGE WESTINGHOUSE has devised a new system of suspension for automobiles, which he regards not as a mere shock absorber but as "a shockless spring." The device consists of a vertical, cylindrical telescoping air-chamber, which takes the place of the usual rigid connection between the frame of the car and one end of each of the four steel springs constituting the ordinary equipment, so that the car body is supported on four cushions of compressed air.

The principle on which the invention operates is clearly shown in Fig. 1, without the special constructions required to make it a practical piece of apparatus. In this elementary form the Westinghouse air-spring consists of a deep metallic cup *A*, attached to the frame of a car and telescoping into a similar cup *B*, of slightly larger diameter, connected with one end of the ordinary steel spring. Charge the chamber formed by these two cups with air, and it will resist telescoping with an action very much resembling that of an ordinary coil spring under compression. The resistance can be regulated by varying the air pressure. Fill the chamber with oil and the volume of the contained air is reduced. For each inch that the chamber is telescoped the air is compressed to a greater percentage of its original volume. Consequently the resistance increases more rapidly than if no liquid were employed.

The device as actually made is shown in Fig. 2. The upper section *A* of the cushion chamber telescopes into the lower section consisting of the tube *B* and the crosshead *E*. The outer tube *C* is simply a mud and dust guard. The tube *B* and the crosshead *E* are surrounded by a guide *D*. The upper end of a shackle or link *G* is coupled to the steel spring forming part of the regular equipment of the car, and the lower end is pivoted to the crosshead *E*. A packing ring *H* fits the inside of the tube *C*.

An air-inlet valve *J* covered with a perforated cap, filled with fibrous filtering material, constitutes what Mr. Westinghouse calls a "breather." When the air-spring is compressed the breather sucks air into the annular space between *D* and *C*. When the spring is distended, this air is forced down through the passage *K* into a port partially surrounding the tube *B*. The air flows out between the guide and prevents the entrance of grit and dust. A felt-wiper ring *F* is a further protection against dust.

The real essence of the invention is the apparatus fixed to the lower end of the chamber *A* and shown in detail in Fig. 3. This is a piston, in the sense that it carries the packing for the telescopic joint; but inasmuch as there is a passage through it to provide communication between the spaces above and below it, it is not really a piston. The term is used only for the sake of convenience. The air-spring is normally filled with oil to a height sufficient to cover the piston. Hence the packing is completely oil-sealed, and air cannot escape. Plain leather packing rings *P* and *Q* and a cup-leather packing *R* provide a durable and nearly frictionless packing. The small quantity of oil that escapes past the ring *Q* and the cup-leather *R* is caught in the annular chamber *S*, whence it runs through the vertical passage indicated by dotted lines into the chamber just beneath the ball valve *T*. A small single-acting pump is provided having a hollow plunger *U*, on the upper end of which are secured two collars *V* and *W*. Between the collars is a sliding disk *X*, the diameter of which is such that it almost fills the slightly constricted passage just above it. The spiral spring pressing on the collar *V* normally holds the plunger at the bottom of its stroke.

When the spring is compressed the downward motion of the plunger causes the oil to flow through it in an upward direction. This current of oil raises the disk *X* until it strikes the collar *V*, thereby lifting the plunger and causing it to draw in a charge of oil. When the spring extends again, the oil current flows through the piston in the reverse direction, carrying the disk *X* downward until it strikes the collar *W* and forces the pump plunger to the bottom of its stroke. The oil that was drawn into the pump cylinder passes by the ball check-valve *Y*, up through the hollow plunger, and is discharged back into the cushion chamber. Oil is introduced into the air-spring by removing the protecting cap *N* and the air valve *M*.

Air-springs are applied to an automobile in such a way that they will co-operate with the steel equipment regularly furnished with the car; for the effect of this combination, according to Mr. Westinghouse, is more satisfying than that resulting from using the air-spring alone.

In Mr. Westinghouse's opinion the little pump that automatically takes care of the oil leakage is the feature that makes his invention a practical and thoroughly mechanical contrivance. He has a high opinion of his invention, too. "The influence of the air-spring on current practice—not only in the automobile industry, but in every branch of engineering involving the use of powerful, reliable, elastic springs—will be so marked and far reaching, that the conception and working out of this one small but vital detail will be ultimately regarded as the most important invention of the present age." We wonder.

The Inventors' Guild Addresses President Taft

A RESOLUTION was adopted at a meeting of the Inventors' Guild, held in New York city on November 24th, 1911, in which the President's attention is called to the patent situation in this country. The President is informed that, having made a proper disclosure of a new and useful invention to the Government officials, an inventor is frequently subjected to unreasonable delay, expense and injustice before obtaining his patent, and after obtaining his patent is not equitably secured in his exclusive right, as the constitution intended the inventor should be secured in return for his disclosure.

The resolution points out that the present patent system has been developed almost entirely as the result of suggestions from persons who do not occupy the position of one of the parties to the contract which every patent represents and who do not suffer damage from the delays, complications, injustice and expense characteristic of the United States patent system and the United States courts which hear patent causes.

According to the resolution, modern trade combinations tend strongly toward constancy of processes and products, and by their very nature are opposed to new processes and new products originated by independent inventors. Hence, competition is restrained in the development and sale of patents and patent rights, and independent inventive thought is discouraged. Under existing methods of trying patent causes, moreover, an inventor-patentee of average means could not, at his own expense, carry to a conclusion an average patent litigation against a wealthy opponent.

The resolution requests the President to recommend to Congress the advisability of appointing a committee to confer with experienced and representative inventors, with the object of promptly accomplishing such reforms as will result in more effectively carrying out the intention of the constitution, and to supplement such recommendations by such executive action as, in his judgment, seems likely to assist in accomplishing immediate reforms.

Simplicity a Merit in Invention

WE do not recall any writer on patent law who attacks an improvement because of the simplicity of the invention, or who fails to pay his tribute to simplicity. One distinguished writer, Walker, says: "If a particular result was long desired and sometime sought, but never attained, want of invention can not be predicated of a device or process which first reached that result on the ground that the simplicity of the means is so marked that many believe they could readily have produced it if required."

Judge Cranch is quoted, saying, "Luck, labor, and inspiration give equal rights in respect to invention." The Commissioner more than sixty years ago wrote as follows: "Simplicity is the essence of true invention, and it is often interesting to see, after a multitude of complicated inventions to attain a certain end, some discerning or perhaps fortunate inventor demolish a whole labyrinth of combinations and arrive at the result by means so simple as to rob invention of its charms; such means as one would suppose should have been the first and not the last resort. Mingled with the surprise are oftentimes feelings of regret and chagrin by his competitors, that they had not discovered this most obvious path."

A Novel Automobile Relief Jack

THE accompanying illustration shows the construction of a relief jack for automobiles. The motor car can be dropped to the floor instantly by simply operating a relief valve. The upright columns which engage the axles are hinged at their base and controlled by spiral springs, allowing them to yield to any obstruction they may come in contact with in running the apparatus over them.

The object of this hydraulic jack is to provide means for relieving the tires of automobiles and motor fire apparatus from the constant dead weight resting on a small portion of the surface of the tire while the apparatus is standing in the fire station. The life of the tire is increased by such a system. The device consists of a heavy diaphragm made up of several plies of ducking thoroughly treated with rubber, which diaphragm is bolted between two concave plates, the bottom plate being solid and a piston passing freely up and down in the top plate which, under pressure, is forced upward and forms a perfect solid bearing for the diaphragm to press against while inflated.

Water or liquid is forced through a center pipe and distributed to each jack which has a travel upward of about 1½ inches. By simply closing a feed valve the water is locked into the jacks, thereby holding the apparatus up high enough to allow the wheels to revolve freely without touching the floor.

The upright columns which project from the diaphragm casing and engage the axles are made hollow in the center with a strong spiral spring passing nearly their whole length and the columns are swiveled at their base, being free to yield to any obstruction which is lower than the axle.

After the machine passes over the columns the spiral spring in the center brings them quickly to a perpendicular position on the same principle as a double-acting door is brought to its center by the action of its springs.

A Two Motor Electric Scrubbing Machine

THE accompanying illustration shows a two motor electric scrubbing machine which is capable of scrubbing 150 square feet of floor space in a minute. The machine sprays the floor with water, from a tank on the handle, and covers a space twenty-seven inches in width at one time.

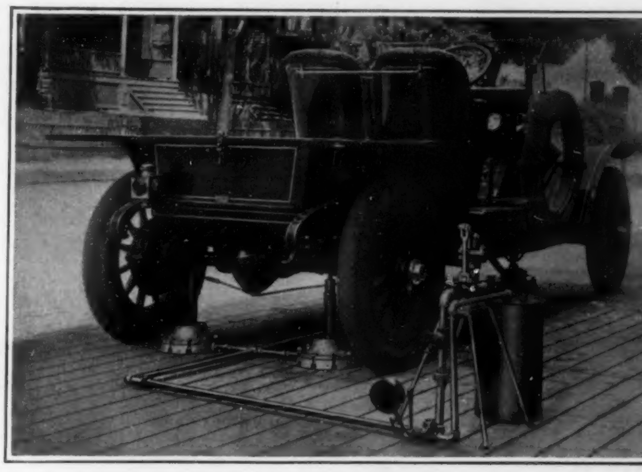
The machine has two ¼ horse-power motors mounted on a shell containing the revolving bases. Disks or brushes are automatically clamped on as may be required. All working parts are inclosed in dust and water-proof cases.

Because the two brushes run in opposite directions the machine is easily controlled.

A Vacuum Cleaner for Railroad Use

A SIMPLE method of cleaning the seats of railroad passenger cars has been developed in Berlin. It consists in a vacuum cleaner operated by steam from a locomotive or high pressure steam plant. The apparatus is shown in the accompanying illustration as applied to a steam cock on a locomotive. It consists of an ejector or aspirator *A*, directly connected with the steam supply, and a steam trap *B* for the spent steam. A suction nozzle *C* is applied to the end of a hose *D*, which communicates with the aspirator through a collector *E*. The last serves to trap dust and dirt collected by the nozzle. The aspirator operates on the well-known injector principle. Steam under pressure passing through it produces a partial vacuum in the hose and collector, thus giving the necessary suction effect at the nozzle *C*. A number of small tubes in the suction nozzle serve to stir up the dust and assist in the cleaning effect. The dust-saturated air is washed by passing it through water in the collector, and the cleansed air passes to the aspirator. The mixed steam and air pass into the trap *B*, where the steam is condensed. The thin slush formed in the collector *E* must be discharged from time to time and replaced with clean water.

This device has been found very effective for cleaning the upholstery and dusting the curtains of cars.



The relief jack in position.

Scrubbing floors by electricity.

Steam-operated vacuum cleaner.

A safe gasoline can.

Side and front views of miner's lamp with gas-percentage indicator.

Miners' lamp with fire-damp cut-out.

A Safety Device for Gasoline Cans

THE enormous increase during the present decade of fires and explosions in garages, cleaning establishments, drug stores, chemical plants and steamships, and in many other places or premises where gasoline, benzine, ether, carbon-disulphide, alcohol and similar highly inflammable liquids are kept, has shown the urgent need of some device which would prevent the dangerous "flare-back," i. e., the communication of a flame to quantities of liquid or explosive gas mixtures kept in cans or tanks. The danger is not so great as long as the tanks are full, for despite the belief of the general public that gasoline will "explode" as soon as touched by a flame it really does nothing of the kind. It will burn—but it will not explode! The danger begins when the receptacles are partially emptied, or even fully emptied of the inflammable liquid itself, leaving in the tank or can only the fumes mixed with a certain quantity of air. These explosive mixtures of gasoline or benzine vapor and air are about as safe as a can of nitroglycerine struck by a steel hammer.

How to prevent this explosive mixture in gasoline and benzine tanks from igniting is a problem that has puzzled inventors for some time. The latest of the devices designed with a view to such prevention is the Langrehr tube, a German invention, which comes to this country with the strong endorsement of the German government, which after exhaustive tests ordered the installation of the Langrehr tube on all gasoline and benzine tanks and cans used on the German warships.

The device is based upon the fundamental principle of the Davy safety lamp for miners, in which the flame is shielded or surrounded by a fine wire mesh screen. This screen serves to cool the products of combustion and prevents the flame from igniting gases surrounding the screen. In the Langrehr device the screen is supplanted by a metal tube, from 6 to 18 inches in length, closed at the bottom and furnished with a double screw thread at the top. The accompanying illustration shows how the tube is inserted in the can. The former consists of a strip of metal, about one inch wide, smooth on one edge and corrugated on the other, wound in spirals so as to form a great number of openings whose aggregate cross-section area is almost equal to that of the mouth of the receptacle.

Fire-damp Alarm for Mines

By the English Correspondent of the Scientific American

FOR some time past efforts have been made in Great Britain toward the evolution of some simple device whereby the miner might be provided with a means of detecting instantaneously the presence of fire-damp in a mine. Some time ago an ingenious appliance was evolved for fulfilling this requirement, but the information thus gathered was communicated only to certain points in the mine, where warning was given audibly and visually. Mr. J. B. Atkinson, the Government Inspector of Mines for the Newcastle District of Great Britain, was impressed with the serviceability of this apparatus and suggested that it should be modified if possible toward a portable form, which every miner might be able to carry about with him. The suggestion was adopted, and in the course of a recent meeting of the North of England Institute of Mining and Mechanical Engineers, a device designed upon these lines was demonstrated and described.

This latest apparatus is a combination of an efficient warning device and the

miner's electric lamp. It is the invention of Messrs. Holmes and Ralph and through their courtesy we are enabled to illustrate and describe its principles and operation. The apparatus is made in different forms to suit various requirements, but in every instance the fundamental principle is the same. The automatic fire-damp cut-out mentioned above, depends for its operation upon the catalytic action of gas upon platinum, which causes a rise in temperature. The application of the self-same principle to a portable lamp however involved the subjection of various difficulties of a complex character, inasmuch as it was imperative that the lamp should be positive in its action and capable of fulfilling the required object under all and varying conditions.

The simplest type of the lamp comprises the ordinary small incandescent electric lamp and a buzzer or bell which when the air in which the miner is working becomes contaminated to the extent of 2½ per cent or more of gas, commences to sound. This audible warning continues until the miner leaves the dangerous area and regains a purer atmosphere, when automatically the bell ceases ringing; but as soon as the air once more becomes mixed with gas in the proportion mentioned above, it recommences ringing.

The construction of the lamp is simple. There are two compound metal strips so fixed that under normal conditions the ends do not come into contact. Beneath one of these strips is a short length of platinum wire, fixed in clips, in such a way as to be readily removable, and connected in series with the lamp. When the lamp enters a dangerous gaseous mixture the platinum wire becomes heated under catalytic action, the compound strips touch, the electric circuit is completed, and the bell or buzzer is sounded. The second compound strip is used in preference to a fixed contact to compensate for fluctuations in the temperature of the atmosphere. A screw in the cover permits one to switch the light on and off, and should any minute spark be generated it is confined within a gauze protected case.

In order to ascertain the workability of the lamp it may be tested artificially whenever desired, by heating the platinum wire to a bright red heat. This is effected by unscrewing the cover slightly, and thereby a resistance is connected in parallel with the lamp, increasing the current through the platinum wire. Such testing at occasional intervals is advocated, inasmuch as it insures a clean and active surface upon the platinum wire.

In another form the lamp is somewhat smaller, and possesses the advantage of being set for various gas percentages ranging from 2½ per cent upward. In this instance the design is such that when the lamp is brought into gas exceeding the above limit the light either is dimmed or extinguished. In this case it will be seen that visual, instead of audible, warning is extended to the miner. The light is dimmed to such an extent that he cannot see to work, but at the same time sufficient glow is furnished to enable him to find his way to safety. The light can only be restored to its normal brilliancy by the insertion of a new fuse, and as this involves the unlocking of the lamp, it must be carried out at a relighting station.

The construction of this form of lamp is very similar to that of the audible type. Ordinary tin or lead wire fuse is employed together with the compound strips and the platinum wire. When the latter becomes heated under the catalytic action and the compound strips make contact, there is a connection directly across the battery which melts the fuse. Under ordinary circumstances such action would bring about the extinction of the light, but by inserting a piece of wire of high resistance across the fuse terminals a current of reduced potential passes across and serves to keep the lamp just glowing.

In this instance the lamp can be tested by connecting a resistance in parallel with the lamp by means of a holder fitted with two contact studs connected together in the handle by a suitable resistance wire. When these contact studs are applied to two points of the detector the platinum wire is raised to a bright red heat, and the apparatus is caused to operate.

For the officials of a mine a more elaborate apparatus has been designed though equally portable. In this case the lamp not only detects the presence of gas, but also indicates the actual proportion thereof in the atmosphere. The lamp, or a non-catalytic wire, is connected in series with a length of platinum wire. A small differential galvanometer is connected up to three points of the circuit, viz., to the two battery ends and to the junction between the lamp and the platinum wire. The voltmeter has two coils, these being connected in such a manner that when the currents in each are equal no movement is produced on the pointer and moving portion of the instrument. The length and resistance of the platinum wire are so proportioned to the resistance of the lamp or the other wire, that under normal conditions the fall of potential is equal in both, and therefore the currents in the two coils of the instrument are equal.

When the resistance of the platinum wire increases, as must be the case when the temperature increases owing to catalytic action, the current passing is reduced slightly, the voltage across the lamp or wire becomes less, and the voltage across the platinum wire rises. As a result currents of different strengths pass through the two coils of the instrument, the moving system of the latter becomes deflected, this movement being indicated by the pointer. The scale across which the pointer moves is graduated so as to indicate directly the actual percentage of the gas present. In the instrument shown in the illustration the scale reads between 2½ and 4 per cent of gas, the graduation being for each ½ per cent. Even if the gas is only ¼ per cent, a readable deflection is shown upon the indicator. If desired, the instrument can be graduated to show fluctuations between 1½ and 6 per cent of gas if it is not required to give readings of such small increases as ¼ and ½ per cent.

The platinum wire is mounted in a separate cylinder protected with wire gauze, instead of being placed within the instrument case. By this means the platinum is not only readily accessible for removal or renewal when necessary, but it permits of locking and sealing the instrument to keep out the moisture and prevent it from being tampered with. The glass dial is protected by a hinged cover, which when opened also acts as a reflector to throw light upon the dial to facilitate reading the indicator, and also as a mirror in which the movement of the pointer may be seen if the lamp is held below the line of vision. The platinum wire is mounted on a holder which slips into spring-clip contacts and thus can be removed easily and readily when required. It is protected by a thin asbestos tube, placed within the gauze lined tube to screen it from draught.

Use of Patented Invention.—It is fundamental that a patent does not give the patentee any more right to use the thing patented than he has independent of the patent. Its virtue is giving the patentee the right to prevent others from making, using or selling the patented thing without the patentee's consent. That great patent jurist, Justice Blatchford, once had a case before him wherein Congress had made a grant to a party of the sole right to construct and operate telegraphic cables between Florida and Cuba, and in a suit in which such party was defendant the Justice held he was not entitled to use the cable patented by the complainant, and at the same time intimated that the complainant had no right to operate his cable between Florida and Cuba, supporting his holding on the ground that the grant of a patent does not give the patentee the right to invade the house of another in order to make or use his invention.

RECENTLY PATENTED INVENTIONS.

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel.

HOLDER FOR NECKTIES, BUTTONS, PINS, AND LIKE ARTICLES.—J. MACDONALD, 208 West 14th Street, New York, N. Y. The invention relates to wardrobe fixtures and the purpose is to provide a holder for attachment to a wall or other support, and arranged to hold neckties, collar, cuff and other buttons, stick pins, and like articles in a convenient manner and protected against the dust.

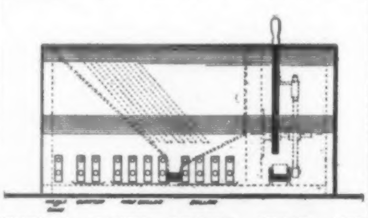
ADJUSTABLE HAT OR CAP.—C. I. MINKOFF and L. KRONTHAL, 483 Broome Street, New York, N. Y. An object of this improvement is to provide a hat or cap having the band so made that it will tightly fit the heads of those who ordinarily require hats or caps of different sizes, thereby providing an article of a single design, a cap or hat, which does away with the necessity of several sizes.

Electrical Devices.

RECTIFIER.—R. A. HAMANN, 421 North 4th Street, Burlington, Iowa. In this case the inventor arranges one or more polarized relays in such manner that when energized by aid of an alternating current, the relay or relays shift the direction of the currents at the proper moment to take advantage of the direction of the current and thus to selectively build up one or more currents of unitary direction.

ELECTRIC GAS LIGHTER.—H. D. GRINNELL, care of Agricultural National Bank Building, Pittsfield, Mass. The aim of the present invention is to provide a lighter more especially designed for high tension currents, and arranged to permit of convenient removal of spark points, for replacing a burner tip by a new one, for cleaning the burner or for other purpose. For this purpose use is made of coiled springs connecting spark points with binding posts connected with a source of electrical energy.

ELECTRIC TICKET SELLING DEVICE AND CHANGE MAKER.—L. L. PIM and J. J. CHRISTMANN, 2241 Wilton Street, Denver, Colo. The engraving in this case shows a side view of a device for vending tickets and making change particularly in theaters and other amusement places. The device is capable of receiving coins of different denominations and of returning therefor one or more tickets and the change in coins of other denominations than that put into the machine.



ELECTRIC TICKET SELLING DEVICE AND CHANGE MAKER.

It provides means for feeding tickets from a continuous roll, and for cutting them from the roll previous to delivery. The electrical means include a set of keys corresponding to the denomination of the coins which may be manipulated so as to affect the closure of circuits for operating the change-making mechanism. It also returns coins placed in slots not intended for them.

ELECTRIC INDICATOR SYSTEM.—S. R. STONE, 731 Carroll Street, Brooklyn, N. Y. Mr. Stone's invention has for its more particular purpose the provision of a system especially suitable for use in large buildings, and provided with a number of separate circuits, each used in various ways and for different purposes, the arrangement being such that the last-mentioned circuits are, as far as practicable, independent of one another.

Of General Interest.

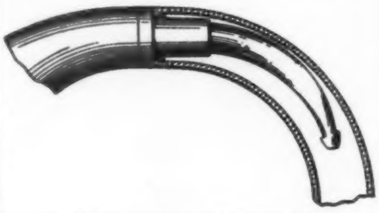
RECEPTACLE FOR GARBAGE AND WASTE PAPER.—I. HOFFMAN, 86 Lenox Avenue, New York, N. Y. In this instance the aim of the invention is the provision of a new and improved receptacle for use in separately receiving and storing garbage and waste paper, and arranged to permit of conveniently carrying the receptacle about and emptying the same of its contents separately.

ATTACHMENT FOR CANS.—T. C. DOREDANT, Box 56, New Orleans, La. This device is for use for cans which contain condensed milk, molasses and other liquids, the device including a handle and a spout, the latter communicating with the can through an opening which is automatically punched in the can by the attachment. The contents are kept fresh and free from dust and other foreign matter in addition to being secured from loss by evaporation, upsetting, etc.

ASTIGMATIC CHART.—G. O. NICHOLSON, 275 Crescent Street, Longbeach, Cal. The object here is to provide a chart arranged to enable the operator, standing a distance from the chart, to conveniently turn the astigmatic disk to any desired position, the disk having but few astigmatic lines, to insure accurate determination of the patient's vision without danger of confusion.

EXPANSION PIPE JOINT.—J. W. WYTON, 5313 Second Avenue, Brooklyn, N. Y. This joint is primarily designed for use in the length of steam pipe running from the boiler to the engine of steamships, although it is adapted for steam and other heated fluid pressure pipes generally. The joint will compensate for the lengthening and shortening of the pipe due to the expansion and contraction, without leak and without use of the customary packings.

COMBINED CANE AND TOBACCO PIPE.—I. HOFFMAN, 86 Lenox Avenue, New York, N. Y. This invention provides a combined cane and pipe arranged to permit of conveniently detaching the pipe from the staff, and to permit separate use of the same. The upper portion of the staff is hollow and curved, and the pipe is detachably connected at its stem



COMBINED CANE AND TOBACCO PIPE.

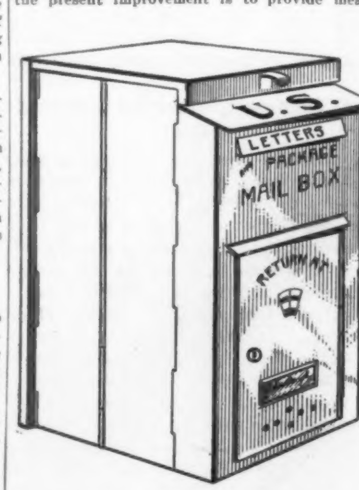
with the upper staff portion, the mouthpiece of the pipe extending within the said upper staff portion, and the bowl of the pipe forming with the said upper staff portion the crook for the cane. The engraving illustrates an enlarged sectional side elevation of the curved upper portion of the cane and the pipe in position thereon.

CIGARETTE CASE.—A. Q. WALSH, 435 Fifth Avenue, New York, N. Y. The invention provides a cigarette case arranged to permit convenient storing of cigarettes, or like smokers' articles, and matches, without becoming tainted by the matches, and to permit convenient removal of the individual cigarettes and matches as desired by the user.

REVERSIBLE BUFFER.—H. MENDELSOHN, 196 Water Street, New York, N. Y. This manicuring buffer has a plurality of working surfaces, and reversible, so as to change the surface exposed to use. The object is to provide a buffer with two sides, one for use with pumice and the other for powder; and so connect the buffer to a handle that it can be readily reversed in a simple manner, so that first one surface can be used, and then the other.

LEVEL ROD.—F. W. WILLIS, 40 F. L. Gibboney, Roanoke, Va. This invention relates to surveying instruments, and its object is to provide a new and improved level rod, arranged to permit convenient and quick repainting of the scale parts in case the same become dim or soiled, and without requiring skilled labor.

LETTER AND PACKAGE MAIL BOX.—C. OHLSON, P. O. Box 35, Courtland, Cal. This invention is an improvement over that disclosed in a prior patent No. 922,181 granted to Mr. Ohlson. The engraving represents a perspective view of his box folded for receiving letters, a door being open. An object of the present improvement is to provide means



LETTER AND PACKAGE MAIL BOX.

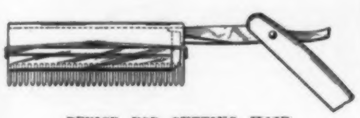
for causing the box to swing open from its closed position. This is accomplished by means of a catch and a spring bottom, so that when the catch is operated it permits the spring bottom member to force the sides outwardly. This catch, it may be stated, can be operated by one hand. A novel form of lock retains the box in its opened and extended position and for releasing it when closing it into its compact form.

Hardware and Tools.

HEDGE TRIMMER.—J. S. JOLINE and E. H. WHEELER, 618 Vernon Street, Long Branch, N. J. The principal object which the present invention has in view is to furnish a guide member for a hedge trimmer to enable the operator to maintain constant the path of operation. With this in view the improvement consists in providing an elongated plate or rear extension member alined with the cutters to guide the trimmer.

PIPE CLAMP.—S. G. MILLER, Russell, Kan. Provided in this invention is a clamp by means of which a well casing or similar body can be securely gripped at any point thereof so that the casing can be withdrawn, which is adjustable so that a single device can be used with pipes of different sizes, which will operate to grip the pipe with increasing force as its resistance in being withdrawn is augmented, and which can be manipulated easily and rapidly.

DEVICE FOR CUTTING HAIR.—F. E. FOOKS, 1517 East Baltimore Street, Baltimore, Md. This invention refers to improvements in devices for cutting hair, and a side view of the device as applied to a razor is shown in the accompanying illustration. An object is to provide a simple means by which an ordinary razor may be used by a person for cutting his own hair without any danger of mutilating himself. Again the object is to provide a device which may be applied instantly to an ordinary razor for enabling the latter to be used in hair cutting. The device can be manufactured cheaply.

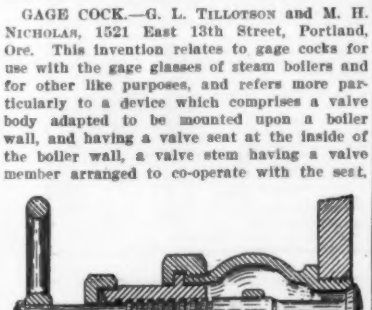


DEVICE FOR CUTTING HAIR.

Heating and Lighting.

SYSTEM AND APPARATUS FOR GENERATING AND BURNING OIL GAS.—F. J. ORR, 761 Prospect Avenue, Buffalo, N. Y. This invention provides a construction whereby oil and air in regulated quantities are mechanically mixed beyond the influence of the furnace and delivered under pressure to the burner within the furnace; provides for mechanically mixed oil and air delivered to an inclosed chamber to be therein baffled in the presence of heat; provides a burner having a plurality of tortuous passages through which mechanically mixed air and oil are passed in the presence of heat to become fixed as gas and having suitable orifices for the ejection of gas therefrom; and among other objects provides for delivering oil and air to a burner so that the suspension of air pressure causes a cessation of the flow of oil.

GAGE COCK.—G. L. TILLOTSON and M. H. NICHOLAS, 1521 East 13th Street, Portland, Ore. This invention relates to gage cocks for use with the gage glasses of steam boilers and for other like purposes, and refers more particularly to a device which comprises a valve body adapted to be mounted upon a boiler wall, and having a valve seat at the inside of the boiler wall, a valve stem having a valve member arranged to co-operate with the seat, and a sleeve associated with the body and having threaded engagement with the valve stem. While particularly useful as a gage cock, the device can also be advantageously employed for other uses, for example, as a drain cock for steam boilers or other containers of fluids under pressure. The engraving presents a longitudinal section showing the same applied to a steam boiler, and serving as a drain cock.

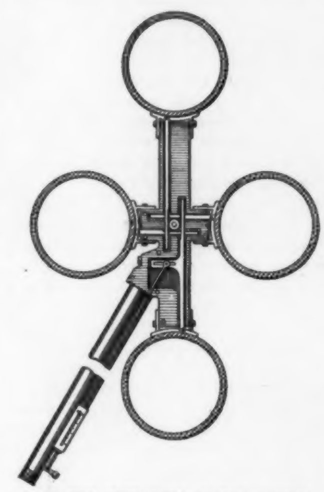


GAGE COCK.

HUMIDIFIER.—R. C. HERREN, Kenton, Ohio. It is desirable that the humidity present in a room be of a certain amount but the hot air heating systems supplying heated air is lacking in the proper amount of humidity. The principal object of the invention is to provide means for insuring moisture in the heated air supplied by such a furnace, the said means being provided with devices actuated by the furnace whereby the operation of the humidifying means is insured by the heating walls of the furnace.

MEANS FOR PROTECTING WATER GAGE TUBES OF STEAM BOILERS.—G. E. E. DEGEORGIS, 11 Rue Pinel, St.-Denis, Seine, France. Owing to the fact that the water gages of steam boilers consist of a glass tube in communication with the boiler, serious accidents are apt to occur in consequence of the internal pressure bursting the tube and violently projecting the fragments of glass along with the steam and boiling water into the atmosphere. This invention enables this defect to be overcome.

TOOL FOR SPREADING BOILER TUBES.—A. P. GERALD, 92 Poplar Street, Jersey City, N. J. In certain types of water tube boilers, it is customary to space the tubes apart intermediate their ends by fire brick of a special design and adapted to engage with two tubes in substantially the same vertical plane and with tubes in substantially a horizontal plane. These fire brick constitute protecting walls or facings for the baffle plates, and it is desirable that they form a substantially continuous wall. After the boiler has been built or used some time, it often is necessary to replace brick without dissembling the boiler. For this purpose, the tool herewith shown in a side elevation with the casing of a portion of the indicating means being removed, is constructed so that the active members move in opposite directions in a straight line against opposed adjacent faces of each pair of tubes, to spread them apart in a straight line.



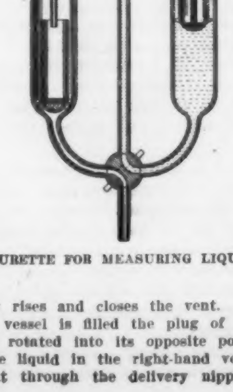
TOOL FOR SPREADING BOILER TUBES.

Machines and Mechanical Devices.

ANIMAL TRAP.—J. F. WINKLER, Box 86, Dollar Bay, Mich. This improvement provides an inexpensive device of the striker type, wherein the holding means for the striker is held in set position by means moving longitudinally of the trap instead of vertically and connected directly with the bait support. All the latch or trigger mechanism is on one side of the pivotal connection of the striker, and on that side occupied by the striker when in set position.

EXPANSION COMB.—P. WILSON, Box 373, Maynard, Mass. Mr. Wilson's invention is for use in warping, beaming and other textile machines, and his purpose is to provide a construction which will more securely support the teeth or dents of the comb and permit of the distance between the teeth being more readily adjusted to suit the various conditions that arise in actual practice.

BURETTE.—J. DECEW ROSE, San Antonio de los Banos, Cuba. This invention is especially useful in laboratories and similar institutions. The engraving shows a vertical central section through this burette, the operation of which is as follows: Liquid to be measured is admitted through a cock into either of the vessels, such as the one at the right, indicated in the figure. As the liquid rises in the vessel, the float also rises until it touches the lower end of the nipple, when the mercury rises and closes the vent. As soon as the vessel is filled the plug of the stop cock is rotated into its opposite position so that the liquid in the right-hand vessel will flow out through the delivery nipple, while the other vessel will be put in communication with a feed tube so as to be filled in the same manner described. The vessels should be measured so that the contents will be accurately known. This apparatus is for sale by Bausch & Lomb Optical Company, Rochester, N. Y.



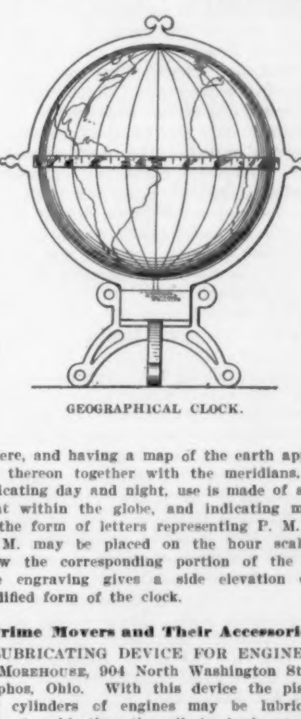
BURETTE FOR MEASURING LIQUID.

CASH REGISTER OR CHECK TILL.—F. A. M. CHAPON, 23 Rue Jean Jacques Rousseau, Paris, France. This invention is constructed so as to deliver to a customer a ticket bearing the amount of the transaction effected and also all the data necessary to enable this transaction to be verified. Moreover, a band remaining in the interior of the till serves as a check by receiving records of all the transactions effected, together with the data peculiar to each of them.

KEG RINSING MACHINE.—G. D. PRENTICE, 645 West Quartz Street, Butte, Mont. In the present patent the invention is a machine for use in rinsing or washing out casks, kegs, or other receptacles, the same being caused to operate automatically by the weight of a cask or keg placed in due position on the machine and requiring no attention or manipulation.

LOADED TRUCK COUNTING APPARATUS.—R. MCGAHEY, 504 East Sumach Street, Walla Walla, Wash. The principal objects which the present patent has in view are: to provide means for locking the apparatus to prevent the same operating except when a loaded truck is passing thereover; and to provide an operating mechanism more sensitive in its action to increase the scope of the employment of the apparatus.

GEOGRAPHICAL CLOCK.—G. KRETSCHMAR, Paauilo, Hawaii. This invention relates to horology, and its object is to provide a clock, arranged to permit convenient reading of the correct time for any geographical point on the earth. For the purpose mentioned use is made of a clock-driven sphere, having a reflecting surface, and provided along the equator with a graduation indicating the twenty-four hours and sub-divisions of the day, and a transparent cylinder surrounding the sphere, and having a map of the earth appearing thereon together with the meridians. In indicating day and night, use is made of a red light within the globe, and indicating means in the form of letters representing P. M. and A. M. may be placed on the hour scale to show the corresponding portion of the day. The engraving gives a side elevation of a modified form of the clock.



GEOGRAPHICAL CLOCK.

Prime Movers and Their Accessories.

LUBRICATING DEVICE FOR ENGINES.—D. MOREHOUSE, 904 North Washington Street, Delphos, Ohio. With this device the pistons and cylinders of engines may be lubricated without subjecting the oil to back pressure generated within the cylinder itself. The cylinders of steam engines which employ superheated steam may be lubricated without subjecting the lubricating fluid to intense heat of the steam itself. The piston of an internal combustion engine may be by this device lubricated directly without coming into contact with explosive gases.

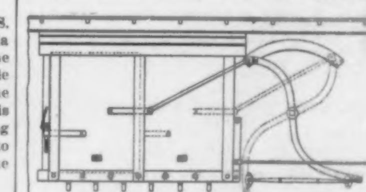
Railways and Their Accessories.

ADJUSTABLE AXLE NUT.—LARKIN BECK, Kirtland, New Mexico. The objects here are to provide an axle nut which may be progressively fed on to the axle as the latter wears away, in order to take up end play; to provide a lock nut which may be adjustably positioned on the axle, and which may be locked in such position; and to provide washers in the nut, which former may be moved when desired. These purposes are attained by disposing within a nut, a series of washers bearing against the end of the axle, which washers may be removed when wear occurs, and by making the pitch of all axle threads equal to the thickness of these washer members, the locking groove and pin will always be brought into alinement. A modified form of the invention carries a locking key. The inserted engraving shows a transverse sectional view through a preferred embodiment of the invention.

ADJUSTABLE AXLE NUT.

LUBRICATOR.—E. E. COPE, 101 South Franklin Street, Dubois, Pa. In this case the invention relates generally to lubricators or lubricating devices and more particularly it involves an improved form of construction especially adapted for use with the air cylinders of air pumps or compressors and more particularly on the air cylinder of an air pump on a locomotive.

CAR DOOR.—A. S. COLTHARP, address Tallulah, La. The object of this invention is to provide a door especially adapted for freight cars, which will move easily in opening or closing, and which may be opened and closed by a single lever, and which will be strong and incapable of accidental dislodgment, and will not leak, sag, rise or move laterally. This door is shown in the engraving by a side view of a portion of the car provided with the improvement whose operating mechanism can be attached to cars already in use with but slight changes and no changes in the construction of the body.



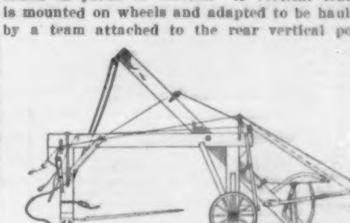
CAR DOOR FOR FREIGHT CARS.

AUTOMATIC FENDER.—G. HIPWOOD, 51 West Twelfth Street, New York, N. Y. This invention relates to a fender to be used on cars or any other suitable vehicles, and it is of that type in which a drop-fender is adapted to be lowered by the engagement of an obstruction with a trip gate. An object is to provide a drop fender with a trip gate for releasing the same, the said gate having a limited vertical movement whereby unevenness in the ground or in the rocking motion of the car may be allowed for.

CAR WHEEL.—C. B. PRITCHARD and G. T. POTTER, Everson, Pa. This invention provides a wheel constructed and arranged to form a receptacle to carry an increased supply of lubricating grease; provides means for readily and quickly supplying and automatically delivering the lubricant from the receptacle provided; and provides for economizing the construction while increasing the carrying capacity for the lubricant.

Pertaining to Vehicles.

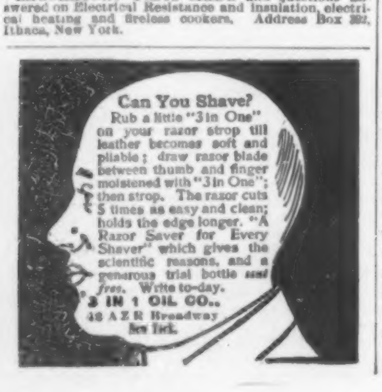
MANURE LOADER.—C. ELSASSER, 1213 Bluemont Avenue, Manhattan, Kan. The apparatus illustrated herewith in a side elevation, shows the lever and connected parts in position there held when it is hauled forward to take up the load, and is for use in taking up and loading upon wagons, manure or offal found in yards or corrals. A vertical frame is mounted on wheels and adapted to be hauled by a team attached to the rear vertical post of the frame, the same having a caster wheel to enable the frame to be readily turned to right or left. In front is a long beam constituting a lever which swings vertically in the frame and whose front end is provided with a fork and other devices to seize and take up manure and other material and to hold it as the lever deposits it upon a wagon. Means provide for releasing the fork and devices and for hauling out the material on the fork from the great body of material before the lever is tilted to raise the load.



MANURE LOADER.

AUTOMOBILE CHASSIS.—W. H. BELL, care of O. J. Karsch, 124 West Eighty-fifth Street, New York, N. Y. This invention provides a supporting frame for an automobile frame connecting the wheel and axles, said body constructed and arranged to provide resilient supports, the vibration whereof are slowed; and also provides resilient members to normally separate the structural members thereof.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.



Mt. Wilson Solar Observatory

(Concluded from page 157.)

of the telescope mounting. At an expense of $40,000 the trail was widened to a wagon road. The heaviest parts of the mounting weighing up to five tons each were hauled to the top on a powerful automobile truck. The lighter parts were taken up on wagons drawn by four mules each, as this was the more economical method.

As considerable electrical energy is needed for both power and light a power plant forms a very essential part of the observatory equipment. A 25-horse-power gasoline engine and appropriate generator are used to charge a storage battery. From this the energy is distributed to the various buildings.

In Pasadena are located the offices of the observatory; the physical laboratory; the library; the optical, machine and pattern shops and the draughting rooms. A large part of the computing and plate measuring is done at the offices by the computing division consisting of six young ladies. In the optical shop have been ground and figured the mirrors of the two tower telescopes, the 60-inch mirror and its auxiliaries, and many others that have been needed for various purposes. Among the last are a 3-foot paraboloid of 25 feet focus, and two test planes of 20 and 36 inches aperture, respectively. The grinding and figuring of the large mirror and its auxiliaries for the 100-inch telescope will be the next work of any magnitude undertaken. Before the completion of this task, however, it will be necessary to figure a 60-inch plane mirror to be used in testing the 100-inch.

The observatory is unique in that the homes of the various members of the staff are not located at the observatory but in Pasadena. The working time with the various instruments is divided among the different observers, who reside on the mountain only during their respective observing periods. The observational material obtained, consisting almost wholly of photographic negatives, is then taken to the Pasadena offices, where the reduction is carried on with the help of the computing division. In this way the observatory has all the advantages of its mountain location while its observing force is not isolated from the remainder of the world except for limited periods of time.

This newest among the large observatories of the world, under the enthusiastic leadership of its director, Dr. Hale, appears to have a great future in store. As times goes on new truths will undoubtedly be discovered and these, added to the results of many devoted workers in this and other lands, will help to give the human race a better understanding of the great Universe of which the earth is so insignificant a part.

In conclusion I wish to acknowledge my indebtedness to Mr. Drew of the observatory force for permission to publish Figs. 1 and 4. The other illustrations are from the regular observatory series taken by Mr. Ellerman.

The Heroisms of Medical Men

By John B. Huber, A.M., M.D.

THROUGHOUT human history there have been many true stories of martyrdom. But the narration of such heroisms among men of science is comparatively rare. Yet science in general, and certainly medical science, has furnished fully as many altruists as any other phase of human life.

Possibly we hear so little of such heroisms because they are rather not expected of science—which many erroneously hold to be frigid, hard, emotionless, constantly torturing lesser creations. Such characterizations are not just, and for the very simple reason that the consistent aim of all science is the benefit and the betterment of humanity; and the most effective science has ever been that in which the service of humanity has been most zealous. Science is simply "knowing," it seeks certainty grounded upon demonstration; but it is none the less sympathetic because it aims to be well poised and of sound judgment.

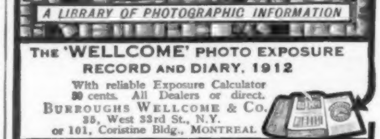
Possibly another reason why the heroisms of science, of medical science at least, are comparatively unknown, is that they are oftentimes achieved in scenes unpleasant and even repellent to the lay mind; they have so much to do with loathsome diseases, do these heroisms. Certainly there are many who do not find things associated with cancer and leprosy, fleas and rats, nice to read or hear about. Few medals for such work are forthcoming (not desired); there is no glamor about them, nothing spectacular. The poet, whose chief excuse for existence lies in his immortalizing magnificent deeds, can get no thrill, no inspiration, out of them. The stake, the drum beat, and the clarion note, by which men march gloriously to death—these engender the mighty line. But whoever can extract even so much as a sonnet out of a death from an experimental mosquito bite?

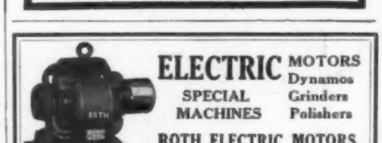
Nevertheless, science has her tragedies and her martyrdoms. In one of our medical colleges is a bronze tablet inscribed *"Haec mea ornamenta,"* commemorative of those of her alumni who died in the practice of her profession, both in the clinic and in the laboratory; and it would indeed advantage all men, were medical science to set up such a monument, not in the seclusion of her institutions, but in the market place. I here set down but several among many names that should thus enduringly be inscribed.

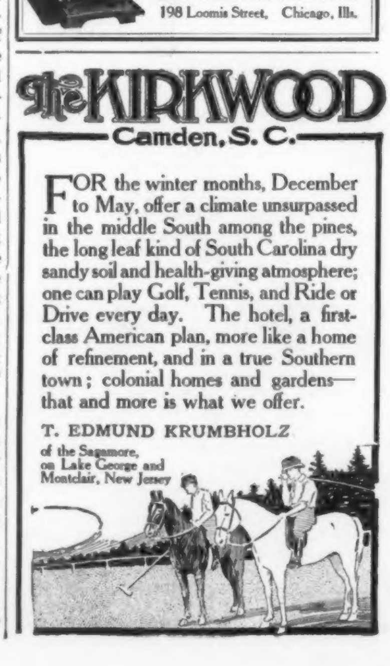
Most touching examples of the torture and death knowingly incurred by workers with the Roentgen rays were set down in an article by T. C. Bridges in these columns of July 24th, a year ago; and I would earnestly ask the reader to revert to this paper. The sacrifices therein recorded on the altar of science were all the more pathetic by reason of the meager therapeutic results that have, after a decade of experimentation, been achieved with this agent. I add now the name of Dr. Mirhan K. Kassabian, whose special work was in X-rays, from the effects of which he died July 12th last in Philadelphia. Though with full knowledge of the dangerous and insidious force he employed, he never for a moment turned aside from the work. For many years before his death he had suffered from superficial X-ray burns. In 1902 his hands were seriously mutilated; in 1908 two fingers were amputated; next year the lymphatic glands were removed from the left armpit. Thereafter several more operations were done; in one of these the great muscles of the left breast were removed, at which time the whole left side of the body was found affected. All that then remained this devoted physician was to await composedly the end. He had for a decade past known full well the risks he was constantly incurring.

Amazing light has of recent years been shed on the problems of human pathology through the agency of biological studies, especially through the work of the bacteriologist and the microscopist. In these fields there are now innumerable laborers, who are constantly in the midst of phenomena dangerous to health and to life, who accept these dangers quite as a matter of course, just as the soldier accepts the possibility of death by the chance bullet. Indeed, therein are the bacterium and the bullet altogether akin. A melancholy instance of how the pathogenic bacterium struck home is that of Dr. William Whitfield Miller, whose promise for the highest kind of original scientific investigation was brilliantly foreshadowed by his report on a subject dealing with comparative parasitology. Dr. Miller died shortly after completing this report, of typhoid fever, which seems to have been contracted while he was studying the origin and prevention of typhoid fever in the District of Columbia—a task to which the Hygienic Laboratory of the United States Public Health and Marine Hospital Service had addressed itself, at the suggestion of President Roosevelt. Thus ended a career of great promise; thus was added another name to the list of martyrs to science and to the cause of humanity.

Dr. Howard T. Ricketts of Chicago also gave his life for humanity and science while investigating typhus fever in the city of Mexico; he contracted the disease "probably by the lice contaminated with the typhus bacteria." A man accustomed to the niceties and the refinements of life, he freely entered circumstances most loathsome and repulsive; of character unassuming, a teacher most inspiring to his students, untiringly zealous, one of







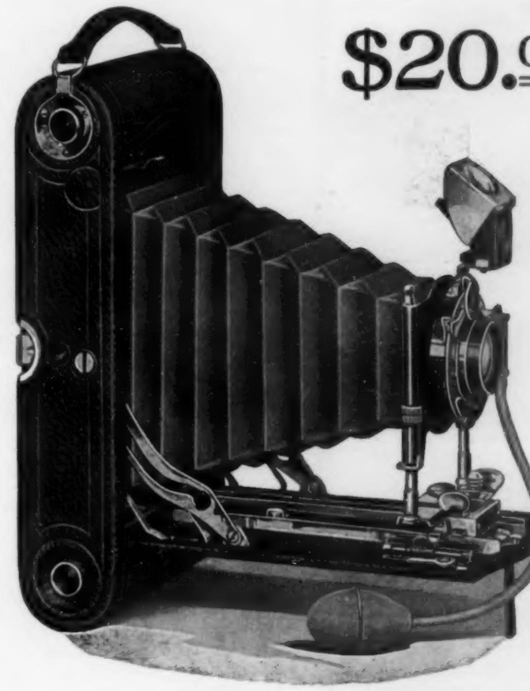
America's foremost scientists, the author especially of a most important book on his subject, Dr. Ricketts was already worn out when he repaired to Mexico for this task, on which account he was probably predisposed, and so readily succumbed to the infection. The predominant characteristic of our civilization is its fierce and conscienceless struggle for money, power, position. What a contrast lies then in this life, which was freely exposed to the gravest of perils, with no other purpose than to solve such problems as remain of human pathology!

In his sixty-fifth year Dr. Robert Koch, the father of preventive medicine, remained for eighteen months on one of the Sese Islands in Victoria Nyanza, fighting incessantly with mosquitoes and ants, and enduring "impossible food;" his only white companion was an army surgeon, and throughout the whole of their stay they saw but three other white men. A rough canoe, hewn out of a single log, was their only means of communication with the mainland; the journey in this to the island lasted four days; "and we were constantly encountering waves hardly inferior in size to those of the ocean." On this island, in a region in Uganda where fevers and epidemics raged, Koch discovered the crocodile's blood to be the chief nourishment of the tzetze fly, the voracious insect which transfers the trypanosomes, the specific cause of the sleeping sickness. This disease, until Koch and his coworkers elaborated preventive and curative measures, was most invariably fatal. To his friend Dr. Libbert he wrote: "The flies engage our attention less than their victims. What a wonderful privilege it is to be able to save human beings who are doomed to certain death! It is this that makes it a real joy to be a physician. It really seems that a way has been found to cure the sleeping sickness."

But it is the purpose of this paper not only to instance individual sacrifice, but also to indicate how such self-abnegation has advantaged mankind. Thus, consider how the white man of this era wants to dominate the tropics. But he has come to understand very definitely that the blessings of civilization cannot be conferred upon the dark-skinned races, that there can be no benevolent assimilation of the latter's territory until medical science has made these tropics safe. It has become admitted and agreed that there can be no permanent conquest south of twenty-three degrees, without the prefatory work of the scientific bacteriologist. His is to-day the new world power; when he has done his work, but not till then, may the rest go ahead in safety; medical science has been the pillar of fire to lighten the way; the bubonic plague, cholera, smallpox, malaria, yellow fever—there is now no reason in logic why these age-long scourges need further to be endured.

In infection-ridden India the Englishman has heretofore been unable to live permanently in health. But the labors of Haffkine, of Shiga, of Ross, and of Manson, who have worked in daily contact with the deadliest toxins, are changing all that; they are making the peninsula salubrious and tenantable by the white man. The devoted physician is pre-eminently and most effectively the missionary of this day and generation; he is eliminating infection from equatorial regions; though there must remain the torrid heat, which induces in the white man the "tropical wrath," the condition characterized by intemperance, and by lassitude punctured with periods of spasmodic mania, and of hideously cruel behavior toward pitifully defenseless natives.

About 1900 a committee was made up of Drs. Walter Reed, James Carroll, and Jesse W. Lazear, non-immunes, and Dr. Aristides Agramonte, an immune. Their purpose was to investigate the theory of Dr. Finlay that it was a mosquito *(Stegomyia)* which conveyed to human beings the virus of yellow fever. These physicians considered that the results, should they prove positive, would be of sufficient service to humanity to justify the procedure presently to be stated—"provided, of course, that each individual subjected to experiment was fully informed of the risks he ran, and gave his free consent." And several soldiers gloriously volunteered. The members of the commission, however, agreed that it was their duty to run the risk involved them-



selves, before submitting anyone else to it.

Upon this decision, Dr. Reed being at the time absent, Carroll and Lazear had themselves bitten by mosquitoes that had been caused to feed upon yellow fever patients. On the night after this momentous event, in writing to Dr. Reed, Dr. Carroll jokingly observed that "if there is anything in the mosquito theory, I should have a good dose;" and so it did result. Coming down with the disease, he was carried to the yellow fever hospital, where for several days his life hung in the balance, and, by reason of the sequelæ of this dreadful infection, his death some years after was premature and untimely.

Five days after Carroll was permitted to leave his bed, Lazear, who had permitted a mosquito to "take its fill," was stricken, and a week later died in convulsions, after several days of delirium and black vomit.

Turn we now to Senate Document No. 520 (issued this year), entitled "The Yellow Fever Commission." Therein Surgeon-General Torrey advocated a grant to Dr. Agramonte, now the sole surviving member of the memorable committee we have considered, and who has never received, either directly or indirectly, any material reward for his share in the labor that was done. Concerning the brave soldiers, and those other than physicians, who submitted to the bites of infected mosquitoes, to have blood or serum from the sick injected into their circulation, and who slept voluntarily in grossly soiled bedding (at that time presumed to have been infected), the Senate Document reports this roll of honor:

Private W. H. Dean, known at the time as "soldier XY," because the experimentation in his instance was done without military authorization, has never been rewarded. Private J. R. Kissinger, whose subsequent ill health has incapacitated him for work, was in 1907 pensioned at $12 a month. A bill increasing this amount to $125 a month passed the Senate, but was objected to by the House Committee on Pensions. Privates L. E. Folk and C. G. Sontag received each $300, and Private C. L. West $200, from an appropriation for the experiments made by General Leonard Wood. Privates C. Jernegan, E. Weatherwalk, William Olsen, W. W. Forbes, P. Hamann, and the civilians A. W. Covington, J. Hildebrand, and J. W. Andrus, each received the same stupendous rewards for risking their lives as certainly as if they had been storming a battery, and for a purpose at least as worthy. Sergeant T. M. England received $100, as did also Dr. R. P. Cook, of Virginia, a contract surgeon. We are not informed how munificent was our government in the case of J. R. Bullard, a Massachusetts man, now farming in Cuba. In the additional experiments made in Las Animas hospital by Major Gorgas and Dr. John Guiteras, the volunteers were eight Spaniards, of whom two died, and a hospital nurse, Miss C. L. Maass, of East Orange, N. J., who died in the cause.

"How discreditable," well observed Surgeon-General O'Reilly, General Torrey's predecessor, "appears this niggardly provision, when compared with the action of the English government, which more than a century ago, when the purchasing power of money was far greater than it is at present, gave to Jenner, the discoverer of vaccination, grants amounting to £30,000; he also received from a subscription in India £7,383, while the Reed memorial has so far succeeded in raising but a little over half that sum." Niggardly—is that the word for a nation that counts its prosperity in billions? How most depressingly ungrateful is this in the American people, in whom lies all responsibility for the acts and the inactions of its legislators!

For, consider but one phase of the benefit which has accrued since Reed and Carroll and Lazear began the work: The Panama Canal Zone, up to very recent years, was one of the most unhealthful spots on the globe; some maintained it had no rival in this gruesome distinction. It has been considered a vast graveyard for those not indigenous to the soil who have ventured thither. Humboldt, after his visit a century ago, stated his belief that the isthmus must always be cursed by "Yellow Jack" and malaria—the former by reason of the decaying mollusks and marine plants appearing on the beach at low tide, the latter by foul emanations from ever-rank vegetation. The master word-painter, Froude, declared that nowhere else on earth was there concentrated in a single space so much foul disease, such a noisome mass of moral and physical abomination. Peculation did much to bring about the failure of De Lesseps, and since his day charges to such effect have not been lacking; but these untoward factors have been negligible by comparison with the hopeless unhealthfulness of the region.

Since then has been done the epochal, heroic work here set forth. Who now fears those epidemics of yellow fever which used to visit our seaboard communities except as hideous memories? From 1902 Gorgas and his associates have made the Canal Zone as infection-free as any in these United States, and much more salubrious than a great many. The last case of yellow fever occurred, I believe, in 1906.

During 1907 Gorgas did not have a single case of bubonic plague to deal with; in that year he had but one case of smallpox; in 1907 he had a fifty per cent reduction over 1906 in malaria, dysentery, pneumonia, and other grave diseases; his death rate in 1907 was more than 61 per cent lower than in 1906. In the territory over which he has jurisdiction (the Canal Zone and the cities of Panama and Colon) he has had in his keeping the health of many thousands of men from widely divergent parts of the earth, engaged in digging through the swamp land of what was probably the most deadly region in existence. In the month of March, 1907, he had under observation 36,000 employees, with 122 deaths.

During the same month of 1908 he supervised 43,000 employees, with only 45 deaths. The mortality rate of the Canal Zone for March, 1908, was less than that of the city of New York, which is one of the lowest, urban or rural, in civilization. The completion of the Panama Canal within the next few years is a certainty; when finished let no one have to be reminded that this splendid work could never have seen accomplishment had not devoted and zealous men, from Finlay to Gorgas, so magnificently died, and lived, in the application of the discoveries and the resources of medical science.

Fluctuations in the Solar Radiation

In his annual report to the secretary of the Smithsonian Institution, Mr. C. G. Abbot, director of the Astrophysical Observatory, reiterates the conclusions that he has expressed in several recent publications as to the fluctuation in the amount of radiant energy given out by the sun.

The great work begun by Langley and continued by Abbot has been the accurate determination of the so-called "solar constant," i. e., the amount of radiation received from the sun by a given area of the earth's surface, allowance being made for the loss due to the presence of the atmosphere. The *crux* of the problem was to estimate the effect of the atmosphere. How successfully this difficulty has been met is shown by the fact that simultaneous measurements of the solar constant made by the spectrobolometric method of high and low sun at sea-level (Washington), at over a mile altitude on Mt. Wilson, California, and at nearly three miles altitude on Mt. Whitney, California, give virtually identical results. Hence Mr. Abbot believes that he completely eliminates the effect of atmospheric losses and determines accurately the amount of radiation that would be received at any given moment if the air were not present.

The "solar constant" results are, however, far from being *constant.* They fluctuate between 1.80 and 2.00 calories per square centimeter per minute. The sun's output of radiation appears to vary from day to day in a manner irregular in period and quantity, but roughly running its courses within periods of 5 to 10 days in time and 3 to 10 per cent in amplitude.

For several months past Mr. Abbot has been making a series of daily observations at a point in the interior of Algeria where climatic conditions are particularly favorable. His results are to be compared with simultaneous observations in America, in order to test further the conclusions stated above.

Notes and Queries.

Kindly keep your queries on separate sheets of paper when corresponding about such matters as patents, subscriptions, books, etc. This will greatly facilitate answering your questions, as in many cases they have to be referred to experts. The full name and address should be given on every sheet. No attention will be paid to unsigned queries. Full hints to correspondents are printed from time to time and will be mailed on request.

(12605) A. L. R. asks: I would like to know whether, when an automobile goes round a turn sharp enough, or at a sufficient rate of speed to make the machine tip to one side or the other, which pair of wheels, the inside or the outside, would leave the ground. The correct answer to this question is of great importance to me. I personally believe that the outside wheels leave the ground, and I have photographs which conclusively prove to me that this is so, but if I could have your written or printed opinion on the matter it would be a very great help. A. If an auto turns over in rounding a turn, it overturns to the outside of the curve, and the inner wheels must leave the ground first. We would ask in which direction do you feel yourself pressed by the centrifugal force of rounding the curve? There is only one answer by everyone who has felt the force produced. You are pressed strongly to the outside of the curve, and lean in to avoid being thrown outward. The circus rider does the same. He knows that he will be thrown outward if he does not lean inward to prevent it. Tracks for races are banked at the turns for this reason.

(12606) O. C. B. asks: I am interested in some work that was carried on by Nikola Tesla on the lines of producing light, a glow, by means of an alternating current generator, that Mr. Tesla designed and made to produce vibrations of great rapidity. I would like to ask you if you can put me in touch with some articles or any books which were published on his works. A. We can supply the book "Experiments With Electricity of High Potential and High Frequency," by Nikola Tesla, for $1. We can also send our SUPPLEMENT Nos. 762 and 763 for 10 cents each, which contain detailed accounts of the similar experiments performed by Prof. Elihu Thomson. Also, papers upon Tesla and his work in SUPPLEMENT Nos. 692, 847, 855, 907, 944, 1004, 1025, 1087, for 10 cents each.

(12607) J. McC. asks: I do not understand why the seasons should not follow the equinoxes in tropical as well as in sidereal years if spring begins at the *time when* and the *point where* the sun crosses the equator. A. Your misunderstanding about the calendar and the beginning of spring seems to come from not remembering that the tropical year is the year on which the calendar is based. See Young's "Elements," Section 133: "Since the seasons depend upon the sun's place with respect to the equinox, the *tropical* year is the year of *chronology* and *civil reckoning*." Also, in Todd's "New Astronomy," page 165, at middle: "Suppose the earth starts from the vernal equinox; while the year is elapsing, this point travels westward by precession, so that the earth meets it in 20 minutes 23 seconds less than the time required for a complete *sidereal* revolution. This is the tropical year, and its length is 365 days 5 hours 48 minutes 46 seconds. It is the ordinary year, and forms the basis of our calendar." The seasons are prevented from wandering through the months by the device of leap years. This was the reason for the reform of the calendar, for which see any astronomy. Todd, page 166; Young, pages 85-87. The sidereal year is not used for the calendar. The calendar year is based upon the time from the crossing of the equator by the sun in March to its next crossing of the equator by the sun in March. Then astronomically spring begins. It is not, however, always on March 22nd. This year being a leap year, the sun will cross the vernal equinox on the civil day, March 20th, the extra day in February moving the calendar time backward by a day. 2. Will you also kindly tell me why the moon travels faster in its orbit on the outside of the earth's orbit than it does on the inside of it? A. The motion of the moon as referred to the earth is a revolution around the earth, and it moves fastest when nearest to the earth, in perigee, and slowest at apogee. The line joining these points which may be located at all points of the moon's orbit in a cycle. The more rapid apparent motion of the moon when outside the earth from the sun is caused by the revolution of the moon around the earth while it accompanies the earth around the sun. It is like the motion of a point on a wheel as it rotates around the axle and goes along the road with the wagon. The moon seems to gain on the earth while outside the earth's orbit, and to lose while inside the earth's orbit. It is due to the two motions of the moon, a motion around the earth and one around the sun. We have many times in Notes and Queries discussed the motions of a wheel. You can refer to these and have the explanation of the motions of the moon.